DOCUMENT RESUME

ED 092 386 SE 017 957

AUTHOR	Melvin, Ruth W.
TITLE	Ohio Environmental Education Areas.
INSTITUTION	Ohio Academy of Science, Columbus.; Ohio State Dept. of Education, Columbus.
PUB DATE	74
NOTE	188p.; Color-coded maps included at request of author
EDRS PRICE	MF-$0.75 HC-$9.00 PLUS POSTAGE
DESCRIPTORS	*Environmental Education; Geographic Location; Guides; Instruction; *Land Use; *Natural Resources; *Physical Environment; *Resource Guides; Resource Materials
IDENTIFIERS	*Ohio

ABSTRACT

This is a guide to regional sites in Ohio which can be studied in regard to resource management; land use; the quality of air, water, soil; and reclamation. The first section of the guide includes brief descriptions of Ohio's natural features at the present time, accounts of past appearances and events, and predictions for the future. In the second section, essential background information is provided for each of the five major watersheds of Ohio, and broad environmental problems are cited and related to the biophysical environment. Detailed descriptions of a wide variety of sites in each region are provided. (DT)

Ohio Environmental Education Areas

Prepared by
The Ohio Academy of Science for
The Ohio Department of Education

Columbus, Ohio
1974

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Front Cover:
Sycamore in Clear Creek Valley

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Shawnee State Forest overlooking the Ohio River.

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Conservationists and scientists began many years ago to warn of the hazards man has created for himself through his abuse and disregard for natural resources. Only now that many of our irreplaceable resources have been devastated is this concern shared widely by the general public.

With this concern has come the urgency that future generations of Americans be provided with environmental knowledge and awareness if our natural heritage is to be preserved. The challenge to educators is clear. By demonstrating to each student his stake in our environment, we can more nearly attain desirable surroundings even as our world grows increasingly urban and technological.

The Ohio Department of Education has developed a series of publications to assist schools in implementing an interdisciplinary approach to Environmental Education. The publications encompass a resource catalog; guides to distinct Ohio environmental study areas; a series of experience units; and a planning guide for outdoor education. In addition, a land laboratory model is being developed on the grounds of the Ohio School for the Deaf.

As part of this undertaking, the department has contracted with the Ohio Academy of Science to prepare these regional guides to sites which can be studied in regard to resource management, land use, the quality of air, water, soil, and reclamation. An advisory committee composed of representatives of the department and the academy guided this significant work, under the direction and authorship of Ruth W. Melvin of the academy.

These guides are offered in the expectation that they will provide teachers with a comprehensive, thorough and accurate tool to meet the imperative . . . and stimulating . . . challenge of educating future generations of environmentally literate citizens.

Martin W. Essex

Martin W. Essex
Superintendent of Public Instruction

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ACKNOWLEDGEMENTS

Much assistance in the preparation of these guides was provided by **Thomas M. Stockdale,** associate professor, School of Natural Resources, The Ohio State University; **Robert Finlay,** supervisor for environmental education (retired), Ohio Department of Education; **Lynn Elfner,** Ohio Environmental Council; **Beverly Lee,** ERIC Center for Science and Mathematics Education; **G. Gerald Acker,** of Bowling Green State University Biology Department, president of the Ohio Academy of Science; and **John Disinger,** School of Natural Resources, The Ohio State University.

The following persons served as regional chairmen for the site studies: **William Taylor,** Independence High School, Cuyahoga-Grand Region; **Paul Webster,** Bryan High School, Maumee Region; **Violet Strahler,** Dayton Public Schools, Miami Region; **Robert H. Mills,** district conservationist, Soil Conservation Service, Muskingum Region; and **Barbara J. Thomson,** Center for Unified Science, College of Education, The Ohio State University, Scioto-Hocking Region.

Donna Szuhy, environmental education director of the Ohio Department of Natural Resources, was responsible for coordinating the efforts of the various divisions in the department to provide the maps for this work.

In addition to authors of selections in **Reading the Landscape,** who are recognized following their contributions, the following contributors submitted descriptions of regional site studies:

Cuyahoga-Grand Region

Goodtime II Cruise: Cleveland Harbor and the Cuyahoga River, and Hayden Avenue Neighborhood Development Program by **Roslyn Glasser,** urban studies consultant, Columbus. North Central Branch, Ohio Agricultural Research and Development Center by **Ronnie J. Johnson,** research associate, School of Natural Resources, The Ohio State University, Columbus. Shaker Lakes Regional Nature Center by **Mary B. Tyler,** volunteer, Shaker Heights.

Maumee Region:

Bryan Outdoor Education Center and Goll Woods by **Paul V. Webster,** Biology Department, Bryan High School. George B. Crosby Park by **Roslyn Glasser.** Port of Toledo and Port Authority by **Mrs. Neil Waterbury,** League of Women Voters, Toledo. Oak Openings and Swan Creek Watershed Studies by **Jeanne M. Hawkins,** naturalist, Toledo.

Miami Region

Cincinnati Nature Center by **Mrs. Kathy Hagist** and other naturalist-educators at the center. Fort Ancient State Memorial by **Joellen Hayes,** Natural History Division, the Ohio Historical Society. Goose Run Valley and the Courts Farm and the Ripley Union Water Association, by **George Roger Courts,** middle school outdoor education director Mt. Orab. Montgomery County Joint Vocational School Program in Outdoor Education by **Gary Bambauer,** teacher at the school. Upper Valley Mall by **Connie Heiland,** Wright State University, Office of Environmental Studies.

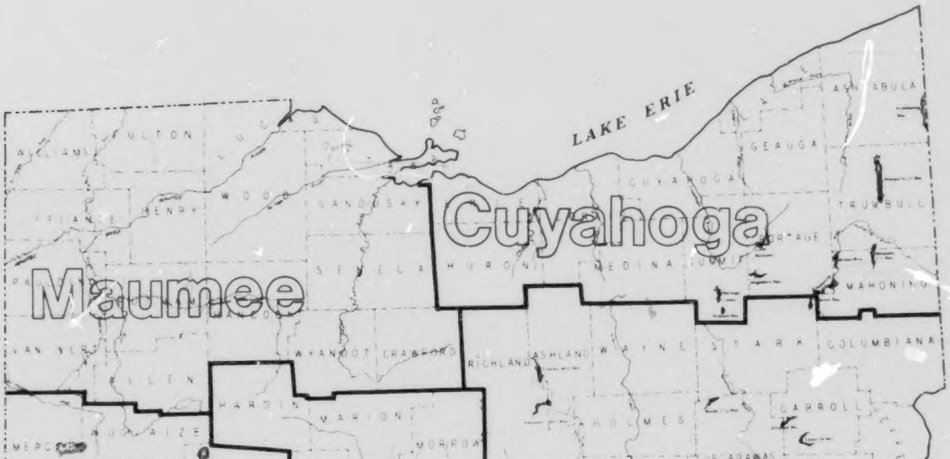
Muskingum Region

Black Hand Gorge by **Mrs. M. C. Markham,** educator-naturalist, the Dawes Arboretum. Canal Fulton Boat Trip and Stark Wilderness Center by **Roslyn Glasser.** Flint Ridge State Memorial by **Joellen Hayes.**

Scioto-Hocking Region

Buckeye Furnace by **Joellen Hayes.** Center of Science and Industry, **William Schmidt,** educational director. German Village by **Roslyn Glasser.** The Southerly Waste Water Treatment Plant by **Dean Freund,** director, Worthington Schools Outdoor Education Program.

Reading
Ohio's Landscape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SENECA
HURON
CUYAHOGA
GEAUGA
ASHTABULA
TRUMBULL
PORTAGE
MEDINA
SUMMIT
MAHONING
VAN WERT
ALLEN
WYANDOT
CRAWFORD
RICHLAND
ASHLAND
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STARK
COLUMBIANA
HARDIN
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CARROLL
MERCER
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LOGAN
KNOX
TUSCARAWAS
HARRISON
JEFFERSON
SHELBY
UNION
DELAWARE
COSHOCTON
CHAMPAIGN
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MONROE
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HOCKING
WASHINGTON
BUTLER
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CLINTON
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ATHENS
HAMILTON
VINTON
HIGHLAND
MEIGS
CLERMONT
JACKSON
BROWN
ADAMS
SCIOTO
LAWRENCE
RIVER
SCALE IN MILES

AN INTRODUCTION

Written on the landscape of Ohio for all to see is a story of interrelationships — rocks, streams, soils, plants and animals. The traveler will not find majestic mountains like Half Dome in Yosemite or valleys carved to the depths of the Grand Canyon. Nevertheless the great forces of nature have been at work here; sunshine and rain, freezing and thawing, erosion deposition, ice advances and ice retreats — all have provided a physical environment for diversified vegetational growth and the animals which consume that vegetation and one another.

Because it was rich in soil and mineral resources man settled Ohio country. He cleared away the forest, utilized the soils for raising grain, and introduced domestic animals. He extracted minerals for his own use and soon found means of supplying his surplus food and minerals to others beyond the state. With developing technology he found ways of using his natural resources to manufacture goods for himself and those beyond the boundary. As his agriculture, manufacturing and trade increased, more people came into the state so that the people-land ratio became greater, the urban areas greater.

The landscape changed. The north-south trending channelways linking two great drainage basins, Lake Erie and the Ohio-Mississippi River system, were altered with damaging effluent from people, agriculture and industry. Streams were dammed for water reserves and flood control, channelized and filled with sediment. While not all of man's activities by any means can be characterized as detrimental to his environment, we are faced with the reality that the quality of life enjoyed by Ohioans is now severely threatened. Immediate action for good environmental management and long term environmental education are essential.

Environmental education asks for a new look at our landscape, not only the natural but man-made features as well. It calls for a total awareness of man's impact on his environment and the environment's influence on man. Environmental education requires a knowledge and understanding of the forces at work which place limitations on the ability of the land to recover from misuse, abuse and overuse. It requires the development of an environmental ethic. This ethic means that man must look for a way of life which considers need along with ability to buy, beauty as well as utility, disposal of waste and recycling as important aspects of buying. It means that the severe old New England adage, "Eat it up; wear it out; make it do; do without," is worth consideration for providing and maintaining a quality environment.

To introduce this new look at our landscape, the pages following are offered as brief descriptions of Ohio's natural features. They give the story of Ohio as it is written on the land at the present time, accounts of past appearances and events, and predictions of what will be. The basic information will provide the foundation for the study of the regions as designated in the second section.

The major watersheds were selected as natural divisions of the state (as shown opposite). The counties embraced within a watershed tend to manifest similar physical environments with plant and animal relationships closely allied. The Indian and pioneer history, the settlement and development patterns are aligned to a considerable degree with the waterways. Environmental problems, many of which are water-related, will be solved only with a comprehensive study of regional situations.

The five regions selected for this study are as follows:

(1) Cuyahoga-Grand Watershed Region embracing twelve counties and including the smaller watersheds of the Huron, Vermilion, Rocky, Black, Chagrin and Ashtabula Rivers.

(2) The Maumee Watershed Region which embraces sixteen counties and the watersheds of the Portage and the Sandusky Rivers as well as the Maumee.

(3) The Miami Watershed Region covering eighteen counties, a small portion of the Wabash River Watershed, the major portion of the Great Miami Watershed, the Little Miami, White Oak Creek and Ohio Brush Creek.

(4) The Muskingum Watershed Region which includes many small rivers draining into the Ohio from East Palestine to Belpre. Twenty counties constitute the region.

(5) The Scioto-Hocking Watershed Region embracing twenty-two counties and the Shade River valley, Raccoon Creek, Symmes Creek and the Little Scioto as well as the Scioto and Hocking Watersheds.

Each region is described briefly for essential background information at the beginning of each section. Broad environmental problems are cited and related to the biophysical environment. Teachers are urged to read this material for a basic understanding before undertaking field studies within the region.

It will be observed that a wide variety of sites have been selected for study in each region. It is to be noted further that few situations are duplicated among the regions. Teachers may use the studies in one region as models for approaching similar situations in the region of immediate concern. For instance, the generation of electric power by means of fossil fuel is described in detail in the Miami Watershed and the Muskingum Watershed Regions. Power plants available for tours are listed in all regions. The same situation follows for steel plants, nature centers, historical sites, river studies, urban analysis and others.

The detailed site descriptions found in each region

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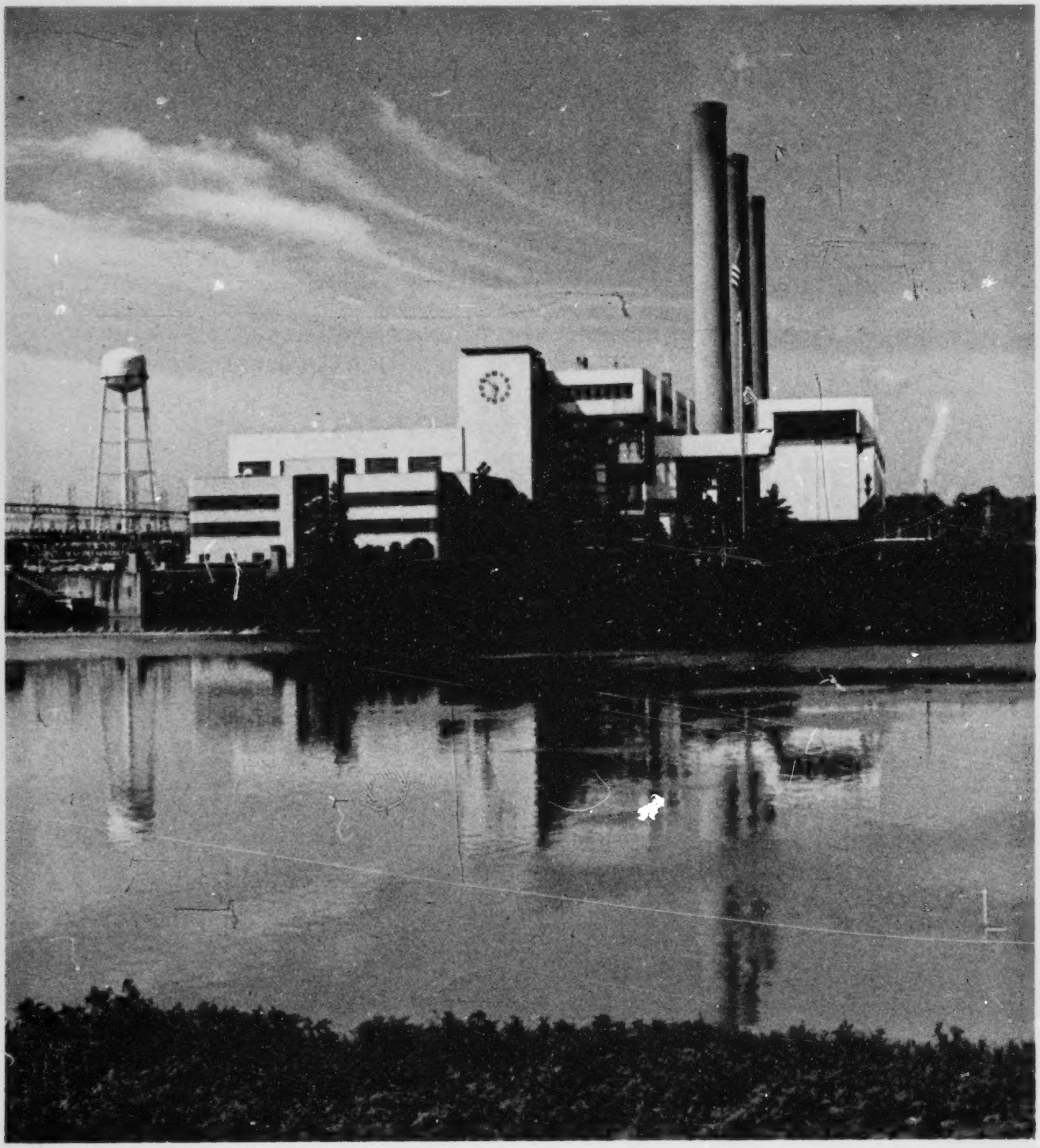
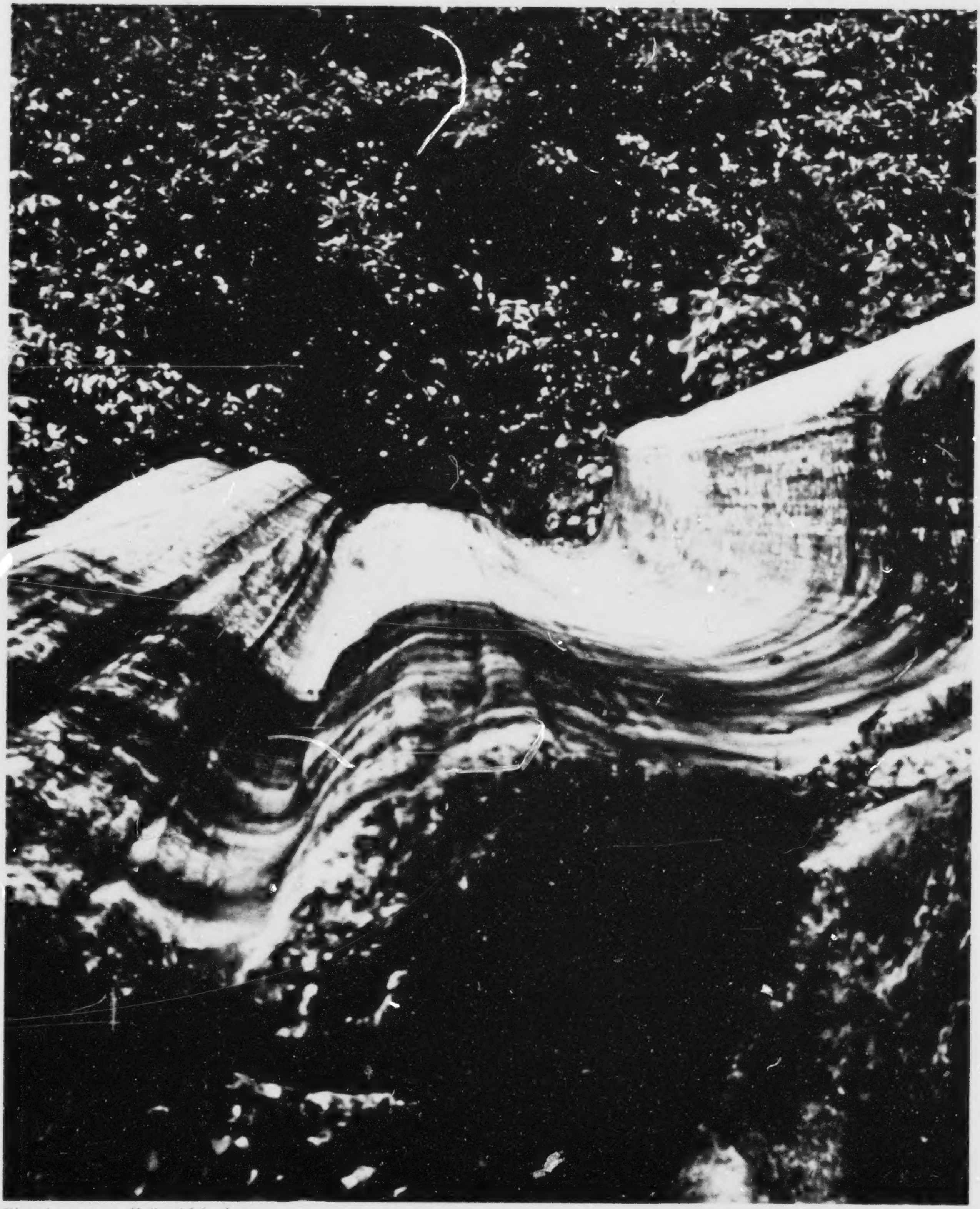
are designed to give basic information to help the teacher undertake a project with some confidence. They are not intended to stop further inquiry on the part of the teacher or discovery on the part of the students. The facts given about the geology and vegetation, the history or the process are never as significant as the observations and deductions made by the students themselves. Valuable as it may be to understand how electricity is generated, the questions still to be answered in regard to what environmental trade-offs may be tolerated remain with the generation of voters gaining objective insights and fair value judgments in their formative years. To this end the following information is dedicated.

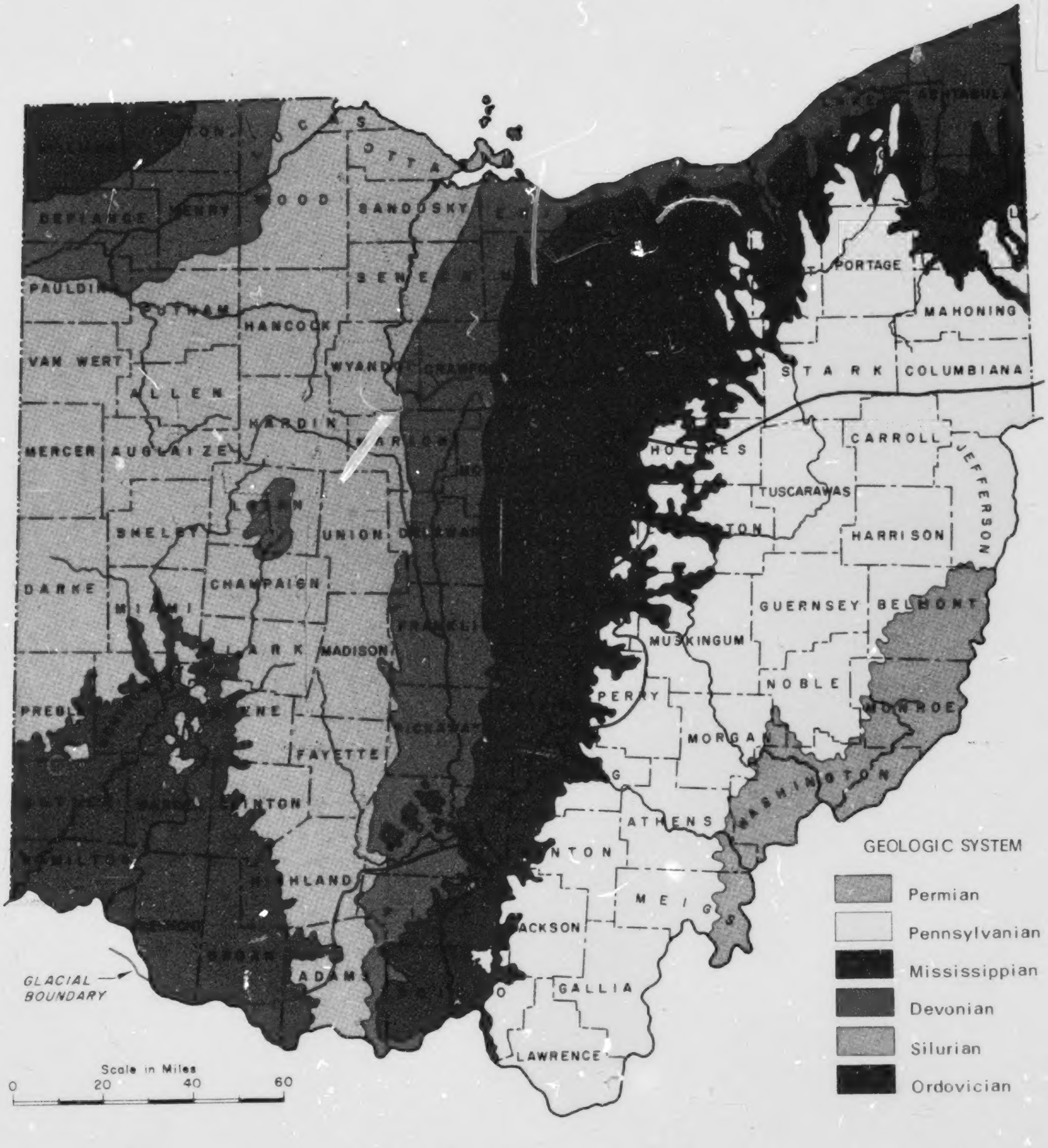


O.H. Hutchings Electric Generating Station on the Miami River



Glacial grooves on Kelleys' Island

GEOLOGIC MAP OF OHIO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ALLEN
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AUGLAIZE
LOGAN
UNION
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GREENE
FAYETTE
PICKAWAY
CLINTON
HAMILTON
HIGHLAND
BROWN
ADAMS
ASHTABULA
PORTAGE
MAHONING
STARK
COLUMBIANA
HOLMES
CARROLL
JEFFERSON
TUSCARAWAS
HARRISON
GUERNSEY
BELMONT
MUSKINGUM
NOBLE
PERRY
MONROE
MORGAN
WASHINGTON
ATHENS
MEIGS
JACKSON
GALLIA
LAWRENCE
GLACIAL BOUNDARY
Scale in Miles
0
20
40
60
GEOLOGIC SYSTEM
Permian
Pennsylvanian
Mississippian
Devonian
Silurian
Ordovician

INFLUENCE OF OHIO'S BEDROCK GEOLOGY ON THE LANDSCAPE

Geologic materials throughout the entire world are of two kinds: the clay or gravel found at the surface and the solid rock, or bedrock, lying underneath. The bedrock may be composed of igneous rocks — cooled from a molten condition, like lava; sedimentary rock formed of compacted or cemented sediments; or metamorphic rock, rock changed by excessive heat and pressure, such as those associated with mountain-making.

In Ohio, the geology is far more simple. Most of the surficial materials are deposits left by the glaciers of the Ice Ages, and all the bedrock is sedimentary. In addition, unlike most other areas of sedimentary rocks in the United States, such as in the Appalachian Mountains of Pennsylvania or Virginia, where the rocks are bent or folded, the layers of sedimentary rock are almost horizontal, resulting in very simple and easily understood bedrock geology.

In western Ohio, the bedrock is mainly limestone, though some shale is also present, especially in the Dayton-Cincinnati area. In contrast, in eastern Ohio, the bedrock is dominantly sandstone, with some layers of shale, and also, still farther east, in the Youngstown-Marietta-Ironton area, with some thin layers of coal. Deep drilling in this area, though, reveals the presence of limestone far below the sandstone, the same limestone as in western Ohio. This limestone can be traced all across the state.

If the sandstone lies on top of the limestone in eastern Ohio, one might wonder why it is not also present in western Ohio. The answer is that the rock layers in Ohio have been bulged upward in a gentle arch, probably formed, at least in part, when the Appalachian Mountains were being pushed up to the east. Because the crest of this arch passes through Cincinnati, it is called the Cincinnati Arch. Where the rocks have been arched up highest, in western Ohio, erosion has cut deepest, resulting in the removal of all the overlying sandstone. This implies that sandstone did indeed lie on top of the limestone of western Ohio at one time, an interpretation generally accepted by geologists and supported by the presence of sandstone in northwestern Ohio and in Michigan. The arrangement of the limestone and sandstone layers, as they occur in the Cincinnati Arch and as they appear after having been eroded, is shown in the diagrammatic cross-section below the geologic map of Ohio's bedrock.

The contrast in kinds of bedrock in Ohio has had an effect on the landscape, for the limestone of western Ohio is a nonresistant rock, wearing away readily and producing plains, whereas the sandstone of eastern Ohio is more resistant, so that erosion of it tends to produce deep valleys and hills, the kind of landscape characteristic of eastern Ohio. This contrast in landscape also affected the Ice Age glaciers, for they advanced southward across the plains of western Ohio all the way to the Cincinnati area, but in the east their advance was impeded by the sandstone hills, so that they extended only as far south as Canton.

The nature and arrangement of the kinds of bedrock also reveal something of the geologic history of Ohio. Both the limestone and the sandstone represent sediments accumulated in an ancient ocean that once flooded all of Ohio, as evidenced by the fossilized sea shells found in the rocks, especially in the limestone. The fossils in the Cincinnati-area limestone are particularly famous for their abundance and excellent preservation. The limestone, the oldest rock, represents an accumulation of lime precipitated far out in that ancient ocean, while the younger sandstone is the naturally cemented sand of beaches and offshore sand-bar areas, suggesting that, as time went on, the ocean became less extensive, draining away, until no ocean was left at all.

This is indicated by the coal deposits, which are the compacted remains of land plants from some of the earliest Ohio forests.

This contrast in the two kinds of bedrock in the two parts of Ohio also plays a basic role in determining the kinds of plants and animals that are present. And it affects man, too, for the kind of rock that is present determines the kind of soil, the kind of natural resources, the availability of water, and the nature of some problems of waste disposal and pollution that man encounters in living in Ohio.

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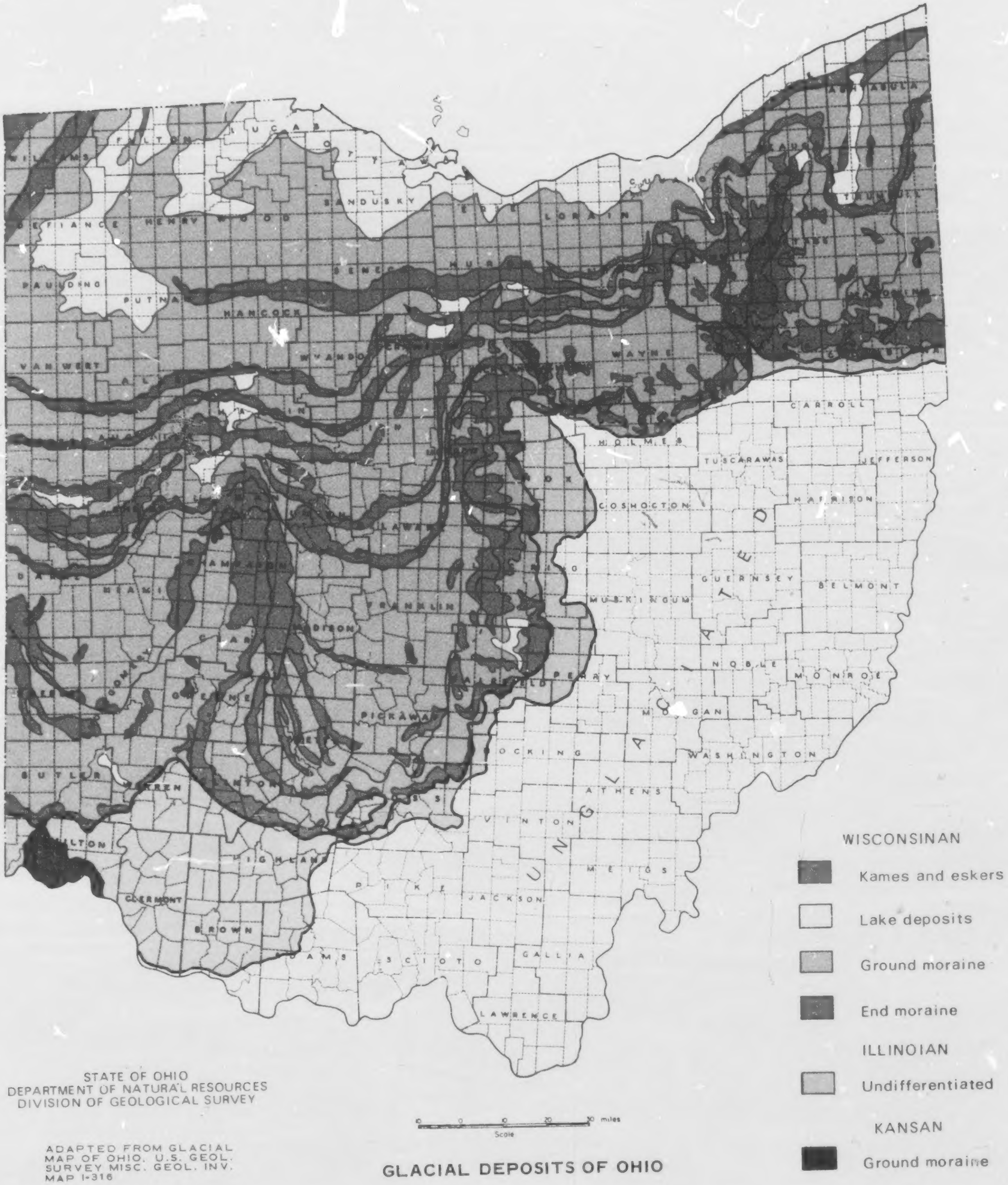
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VAN WERT
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TUSCARAWAS
JEFFERSON
COSHOCTON
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KNOX
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DELAWARE
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MADISON
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MUSKINGUM
NOBLE
MONROE
FAIRFIELD
PERRY
GREENE
PICKAWAY
MORGAN
PREBLE
MONTGOMERY
WASHINGTON
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WARREN
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ROSS
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Scale
WISCONSINAN
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☐ Lake deposits
▨ Ground moraine
▨ End moraine
ILLINOIAN
▨ Undifferentiated
KANSAN
■ Ground moraine

STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY

ADAPTED FROM GLACIAL
MAP OF OHIO, U.S. GEOL.
SURVEY MISC. GEOL. INV.
MAP I-316

GLACIAL DEPOSITS OF OHIO

ICE OVER OHIO

A quick look at the Glacial Map indicates a wide variety of material brought to Ohio by glaciers of different ages covering approximately two-thirds of the state. Dominating the picture are the deposits resulting from the last or Wisconsin stage with its ribbons of green, representing moraines, festooned across much of the state. The moraines consist of rock rubble — sand, gravel, cobbles, big rocks and fine clay, material called till, carried along in the ice itself and left in place when the glacier wasted back. The furthest bands along the line of glaciation are end moraines. The others are sometimes called recessional moraines although some may be end moraines of still earlier glaciation. Both represent stages where the wasting ice stood still for a great many years, leaving its load of rock material when it melted. The lighter green indicates deposits of the same mixed rock material, some of it carried long distances, some consisting of Ohio's own bedrock, picked up and carried along by the ice, left in lesser amounts as the glacier wasted away at a more or less even rate.

Ohio owes much to the glaciers. Glacial times were cold, 11 degrees or cooler the year round, but they brought the rich mineral soils (till) on which we live, and deposited great quantities of precious sand and gravel in valleys. Coming repeatedly, these materials filled ancient valleys 100 to 400 feet deep, making underground reservoirs (buried valleys) out of them for our industrial and city needs. All this mixed rock rubble came from northern Ohio or from Canada as witnessed by the granite boulders foreign to Ohio! Over central Quebec where the furthest boulders were collected, the ice had to grow from two to three miles thick just to flow through the Huron and Erie basins. Even in northern Ohio it had to be nearly a mile high to catch snow all summer and flow in a broad lobe down each of the Scioto and Miami valleys. As the glacier grew, massive ice cliffs crept 100 to 500 feet a year over 68 of Ohio's counties. Here it stayed, fluctuating a little, for more than 4000 years (radiocarbon dates on over-run trees are from 21,000 to 17,000 years ago). But the bottom was melting most of that time due to the earth's trapped heat, plus friction of motion. In evidence it can be observed that it scraped and striated high rock outcrops, gouging into fresh rock five to forty feet deep as shown by great grooves on Kelley's Island. Over nearly everything in these 68 counties it let down a blanket of Canadian and northern Ohio material consisting of old weathered soil, tree trunks, and fresh ground rock flour all mixed together.

The climate warmed between 16,000 and [illegible]0,000 years ago and melted the annual snow plus the huge ice sheet. There were horrendous floods as all meltwater had to run off in two to three warm months. The great valley cuttings (the steep sides of the Miami and the Scioto Rivers, for instance) were made by these torrents under thinning ice. Layers of clean sand and rounded pebbles accumulated in channels all across each valley until the gravel half-filled each south-flowing valley. Spruce and larch grew on the slopes; alder got buried along the water courses. The mastodon liked it here for these were his foods. He died or got buried along flooding water courses.

For 2500 years Lake Erie was trapped by fluctuating and decaying ice over the Buffalo area and this raised Lake Erie to various levels, as much as 200 feet deeper, 14,000 to 11,000 years ago. By 9000 years ago our present climate returned and oaks and elms came back. Over and over again this glacial change of landscape occurred. During the ice retreat and during long glaciation this river gravel and till were put down on top of still earlier glacial layers. Such "stratigraphic" records are found in the outer parts of the region once covered by ice and in depressions where old layers were not scraped off. Even ancient buried soils and forest beds are preserved in spots. Since this record is incomplete the number of glaciations occurring 25,000 to 50,000 years apart is still uncertain. Probably there were at least five periods of coolings and glaciations. Some are reasonably dated at 300,000, 120,000, 60,000, and of course 18,000 years ago. It is no wonder that the Lake Erie basin was scraped broadly and deeply where the shales were soft, and the western half of Ohio was laminated over, layer by layer, until it became a broad smooth plain completely hiding valleys 100 to 500 feet deep in the solid rock beneath.

The fertile farmland found in glaciated western Ohio contrasts sharply with the thin, residual acid soils in the eastern section where the sandstone hills retarded and finally stopped the ice advances. The broad valleys, filled with glacial outwash, provide abundant water and construction material. Ohioans can appreciate these gifts from the Ice Age and yet enjoy the forested hills untouched by the invasions from the North.

Dr. Richard P. Goldthwait
Professor of Geology, The Ohio State University
Formerly Director of The Polar Institute
and Chairman of the Department of Geology

CLIMATE

Unless one happens to be asked on a lovely sunny day what the climate of Ohio is, the answer probably will be "changeable" or "disagreeable." This is due largely to the extremes of heat in summer accentuated with high humidity, frequent low temperatures in winter, and great variability from day to day.

Most of Ohio lies in a climatic region classified as humid continental, warm summer phase (Goode's Atlas 1964). This extends from about the 39th degree of latitude to the 43rd degree. The southernmost tip of the state is mapped as humid subtropical. The mean annual temperature is about 51 degrees, with the extreme south (Lawrence County) averaging 55 degrees and the northeast (Lake, Geauga, and Ashtabula Counties), 48 degrees. The length of the growing season between killing frosts is sufficient for most crops most years, extending from 150 days in the north to 178 days in the Ohio valley and in much of the lake shore region. Two small areas, one in the southwest, the other in the north, enjoy an average of 192 frost free days. The reason for the equal temperatures in the north-south limits of the state is due to the modifying influence of Lake Erie on one hand and the lower latitude and altitude on the other. Early frosts are as likely to occur in the valleys of the south which have thermal inversions, as any other place in the state.

Average annual precipitation varies from 32 to 44 inches, the lowest along western Lake Erie, the highest along the Ohio River, a small area in the southwest and another in the northeast part of the state (From Ohio Water Plan Inventory Report No. 13, based on data from U.S. Weather Bureau, 1931-1960.)

Approximately one half the rainfall occurs during the growing season, a vital factor for the success of diversified commercial agricultural products grown. Rivers draining into the Ohio, and the Ohio valley, are subject to frequent serious floods, now largely alleviated in two areas by efforts of the Miami Conservancy District and the Muskingum Watershed Conservancy District. Droughts also occur. The worst on record was a widespread situation in 1930.

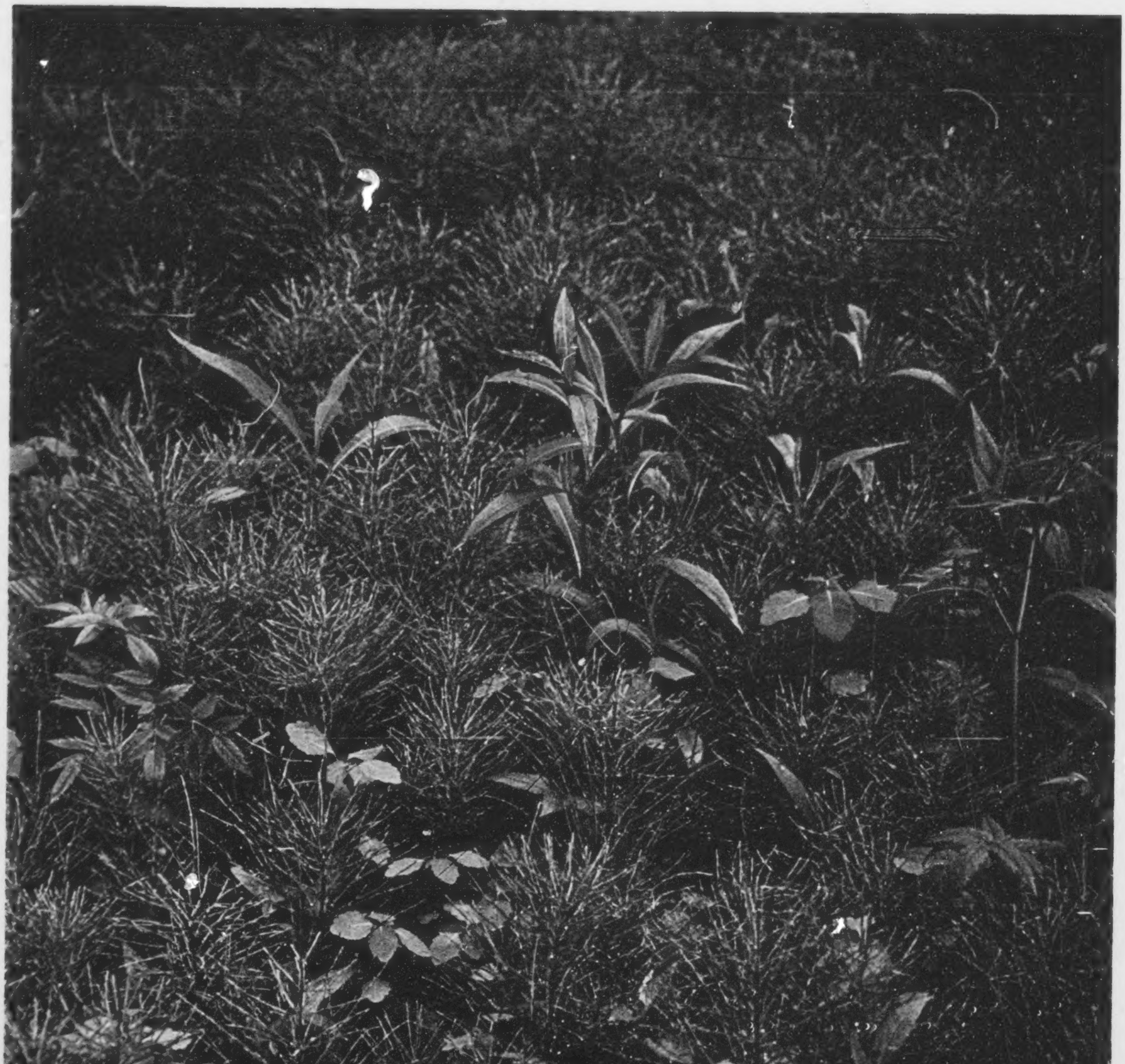
Like other states in the mid-continent region, Ohio is subject to bumping air masses — high and low pressure areas moving from the west and/or south colliding with those from north and/or east. The resulting cyclonic storms develop into thunderstorms, hailstorms, windstorms and heavy rainfall. Occasionally, the sweep of air travelling up the Mississippi valley encounters a mass which induces a true tornado, although Ohio experiences this infrequently in comparison to other parts of the Mississippi region.

For generations Ohioans have moved away from floods when need be, then moved back. New efforts for flood plain zoning and possible evacuation of lake plain areas promise to make flooding less disastrous and expensive.

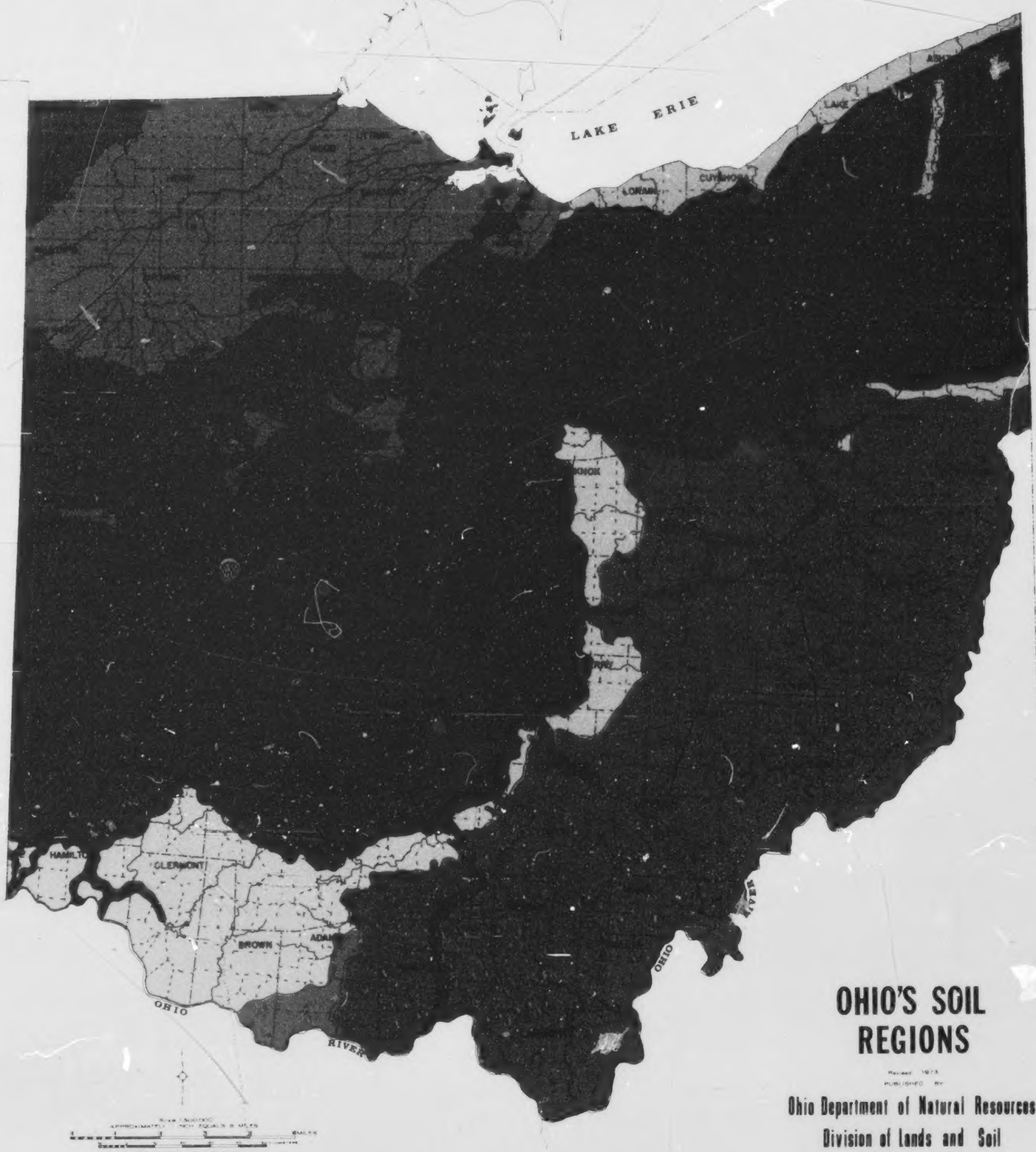
Although Ohio's climate has a specific classification as humid continental, warm summer phase, with predictable general changes, it is advisable to consider also the great variety of microclimates. Essentially a microclimate is the climate of a small area. Due to differences in the amount of incoming solar radiation, topography, windflow, soil or moisture, there are unexpected variations in vegetative cover and/or animal life. These microclimates exist within a plant community, a woodland area for instance, where temperature and moisture differences vary among the leaf canopy, in the understory plants and within the soil layers. Startling microclimatic conditions are discovered in layered water habitats. "Clear" water frequently has a film of life on top, which, when separated, has considerable color and life. Narrow ravines with north and south facing slopes show distinct variation in the type of trees and other plants on each slope. Urban areas may show microclimatic differences in temperature at any given time, variations of ten or more degrees from downtown to the outlying airport.

Man himself is a creator of microclimates to fit his personal desires. His technological devices, including air conditioning, heating units, humidifiers, dehumidifiers, and lighting facilities, provide creature comforts but increase uses of electricity, water and insulation materials. This is man's adaptation, different from that of the other animals and plants as they cope with climatic changes, nonetheless a way for him to inhabit all parts of the world.

Ruth W. Melvin
Project Director
Ohio Academy of Science



Horsetail (Equisteum arvense) vegetation in a woodland


LAKE ERIE
ASHTABULA
LAKE
CUYAHOGA
LORAIN
KNOX
PERRY
HAMILTON
CLERMONT
BROWN
ADAMS
OHIO RIVER
OHIO RIVER
Scale 1:500,000
APPROXIMATELY 1 INCH EQUALS 8 MILES
MILES
KILOMETERS

OHIO'S SOIL
REGIONS

Revised 1973
PUBLISHED BY

Ohio Department of Natural Resources
Division of Lands and Soil
Columbus, Ohio

LEGEND

■ Soils in High Lime Glacial Lake Sediments
■ Soils in High Lime Glacial Drift of Wisconsin Age
□ Soils in Glacial Drift of Illinoian Age
■ Soils in Limestone and Shale
□ Soils in Low Lime Glacial Lake Sediments
■ Soils in Low Lime Glacial Drift of Wisconsin Age
■ Soils in Sandstone and Shale

SOILS OF OHIO

In traveling through Ohio one observes that the surface color of the land changes very rapidly in a short distance. This change in surface color indicates a difference in soils and is related to soil properties. These properties include texture, structure, color, soil reaction, wetness, soil depth and sequence of soil layers or horizons.

We frequently see soils exposed to a depth of several feet in road or stream cuts. These exposures show an observable profile of the soil. A soil profile is a vertical cross section showing layers which are termed "horizons." Soil scientists label them A for topsoil, B for subsoil and C for soil parent material. A profile is approximately four feet deep, which is the weathered or developed A and B horizons. Residual soils are those weathered from the rock beneath and are usually more shallow than the glacial or transported soils where the unconsolidated glacial drift constitutes the parent material.

Observations of soil types in the state reveal that there are strong relationships between the geologic formations or glacial deposits and the soils. A comparison of the four maps — geologic, glacial deposits, soils and original vegetation — shows that lines coincide.

Soil is a part of the environment in which we live. To understand this environment and plan for its improvement requires that we recognize the seven major soil regions.

Soils on High Lime Glacial Lake Sediments

The soils in northwestern Ohio are dominantly dark colored, poorly drained and rich in clay interspersed with light colored silty and sandy materials which have better drainage than the dark colored soils. Drainage is complicated by the fact that the surface of the land is nearly level or gently sloping. The natural fertility is high, except on sand barrens. The soils contain varying amounts of organic matter. Some are formed on clayey, silty or sandy lake sediments or on clayey glacial till which is high in lime. Cash grain farming and specialty crops such as tomatoes and sugar beets are major agricultural uses of these soil types.

Soils on High Lime Glacial Drift of Wisconsin Age

The last stage of glaciation left material derived mainly from limestone and dolomite in a large section of western Ohio. The soils which formed on the glacial drift are dominantly light colored, somewhat poorly drained, particularly in low lying areas. Well drained soils may occur on higher areas. Relief is mostly sloping to undulating. Natural fertility is moderate to high, based on varying amounts of organic matter. Corn, soybeans, wheat, oats and hay crops are grown here under a mixed livestock and grain system of farming.

Soils formed on Glacial Drift of Illinoian Age

In the extreme southwestern part of Ohio soils are formed on materials left by an earlier glacier. They are older, more weathered, and deeply leached. Generally they are strongly acid and moderately low in fertility. They are relatively deep, light in color and vary from poorly to well drained depending on the relief, which is sloping to steep. Cash crops, including tobacco, and general farming are primary agricultural types. Steep slopes are used for woodland or pasture.

Limestone and Shale Residual Soils

A small section of southern Ohio has soils formed on limestone or interstratified limy shale and limestone. Much of the region is hilly, with narrow ridges and steep slopes bordering narrow valleys. The soils are light in color and well drained. Fertility ranges from high to low. Much of the region is in pasture or woodland.

Soils on Low Lime Glacial Lake Sediments

The lake plains in northeastern Ohio have soils derived from lake sediments or glacial till containing sandstone and shale. They are light colored and vary from poorly to well drained. The soils formed on shale are generally low in fertility and organic matter and are generally acid. Much of the region is semi-urban, diverted to housing and industry. Nurseries are common due to the modification in climate extremes relative to the lake.

Soils on Low Lime Glacial Drift of Wisconsin Age

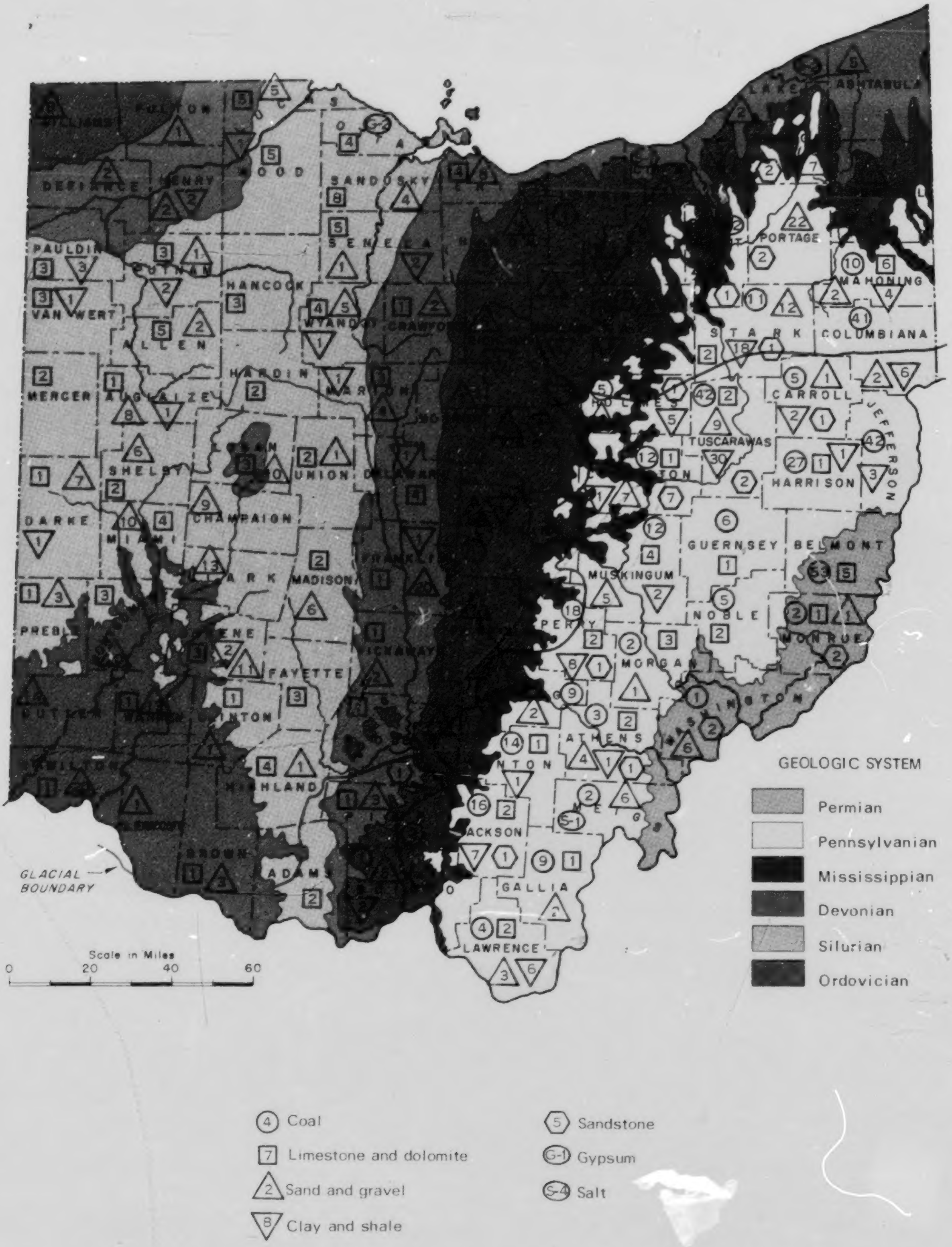
Trending from northeast below the lake plains to southwest is the section of Ohio marking a transition from glacial till plains to rolling hills, the beginning of the Allegheny Plateau. The glaciers penetrated into the hills but not far. The soils formed on the glacial deposits reflect the differences in the topography and the underlying rock strata. The relief is undulating to rolling, the glacial drift mainly derived from sandstone, shale and small amounts of limestone. The soils are generally low in fertility and organic matter and are usually acid. General farming and dairying are the principal types of agriculture. Metropolitan areas encompass large sections of the region.

Residual Soils on Sandstone and Shale

A large section of southeastern Ohio lies beyond the line of glaciation (See glacial map) and its soils are formed directly from the acid sandstones and shales, except for small areas formed on limestone or limy shale. They are mostly light colored and well drained due to a sloping to steep relief. The soils are sometimes moderately deep, low in natural inherent fertility and organic matter. General farm crops are grown on the gentle slopes and in valleys. A high proportion of the land is in forest or pasture.

Department of Agronomy
The Ohio State University and
Division of Land and Soils
Ohio Department of Natural Resources

Ohio's Mineral Resources


GEOLOGIC SYSTEM
Permian
Pennsylvanian
Mississippian
Devonian
Silurian
Ordovician
Scale in Miles
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20
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60
GLACIAL BOUNDARY
WILLIAMS
FULTON
LUCAS
OTTAWA
DEFIANCE
HENRY
WOOD
SANDUSKY
PAULDING
PUTNAM
HANCOCK
SENECA
VAN WERT
ALLEN
WYANDOT
CRAWFORD
MERCER
AUGLAIZE
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PORTAGE
MAHONING
STARK
COLUMBIANA
HOLMES
CARROLL
JEFFERSON
TUSCARAWAS
HARRISON
GUERNSEY
BELMONT
MUSKINGUM
NOBLE
PERRY
MORGAN
MONROE
WASHINGTON
ATHENS
VINTON
MEIGS
JACKSON
GALLIA
LAWRENCE
Coal
Limestone and dolomite
Sand and gravel
Clay and shale
Sandstone
Gypsum
Salt

Figure in symbol indicates number of operating mines or quarries in county

Compiled by Ohio Division of Geological Survey
Mine data from 1971 Ohio Division of Mines Report

BELOW THE LANDSCAPE — OHIO'S MINERAL RESOURCES

Ohio is one of the nation's major mineral-producing states. Currently it ranks about 14th in the total annual value of minerals produced and in 1972 produced minerals worth approximately $702,000,000, according to the U.S. Bureau of Mines. This figure, as large as it is, does not reveal the true value of our mineral production and resources, unless we consider the impact of minerals on everyday life and on our standard of living.

But first let's identify the mineral resources present in commercial quantities in Ohio. (The term "mineral" is used throughout this discussion in a broad sense and includes those materials more correctly termed "rocks.")

Ohio's mineral resources are limited to two groups, known to geologists as industrial minerals and mineral fuels. The industrial minerals include limestone, dolomite, sand, gravel, salt, clay, shale, gypsum, and sandstone. The mineral fuels are coal, oil, and natural gas. All of these resources are commercially produced in Ohio. No metals, gems, or other exotic types of minerals are produced. However, our industrial minerals and mineral fuels put Ohio in the top third among the nation's states in mineral output.

Among industrial minerals, limestone and dolomite are raw materials for lime, chemicals, concrete aggregate, railroad ballast, fluxstone for the making of iron and steel, and agricultural lime. Limestone and dolomite are playing an increasingly important role in the areas of pollution and environmental control. Such controls include use of limestone rock dust in coal mines to reduce fires and explosions and use of limestone and dolomite for filter beds in sewage treatment plants, for neutralization of acid wastes from mines and industrial plants, and for reduction of sulphur dioxide emission from coal-burning power stations. And, of course, the largest use of limestone is the manufacture of Portland cement, which is used in the construction of highways, homes and all other types of buildings.

Sand and gravel are used primarily by the basic construction industry. Concrete is composed of about 85 percent aggregates, of which sand and gravel are the most important. Finer grades of sand are used in plaster, mortar, and concrete block. Any building, street, sidewalk, highway, or other facility in which concrete was used probably contains sand and gravel.

Clay and shale are used extensively in the manufacture of house brick, sewer and field tile, ceramic tile, refractory brick, pottery, and cement. The common house brick or perhaps the "little red schoolhouse" brick must rank as a mineral resource use. Very few homes or buildings do not make some use of the common brick. The sewer systems of cities around the nation make extensive use of vitrified sewer tile; in the eastern United States much of that tile came from Ohio plants utilizing native clays and shales.

Salt is an extremely valuable mineral resource and is important as a major chemical raw material source. Soda ash, used widely in making glass and paper, is one of the most important chemical products based on salt. Chlorine bleach, found in most households, is a common chemical product of salt. Great tonnages of salt are used also during the winter months for snow and ice control on freeways, major highways, and city streets. Common table salt, the most familiar form of the mineral, accounts for an extremely small quantity of the tonnage mined each year in Ohio.

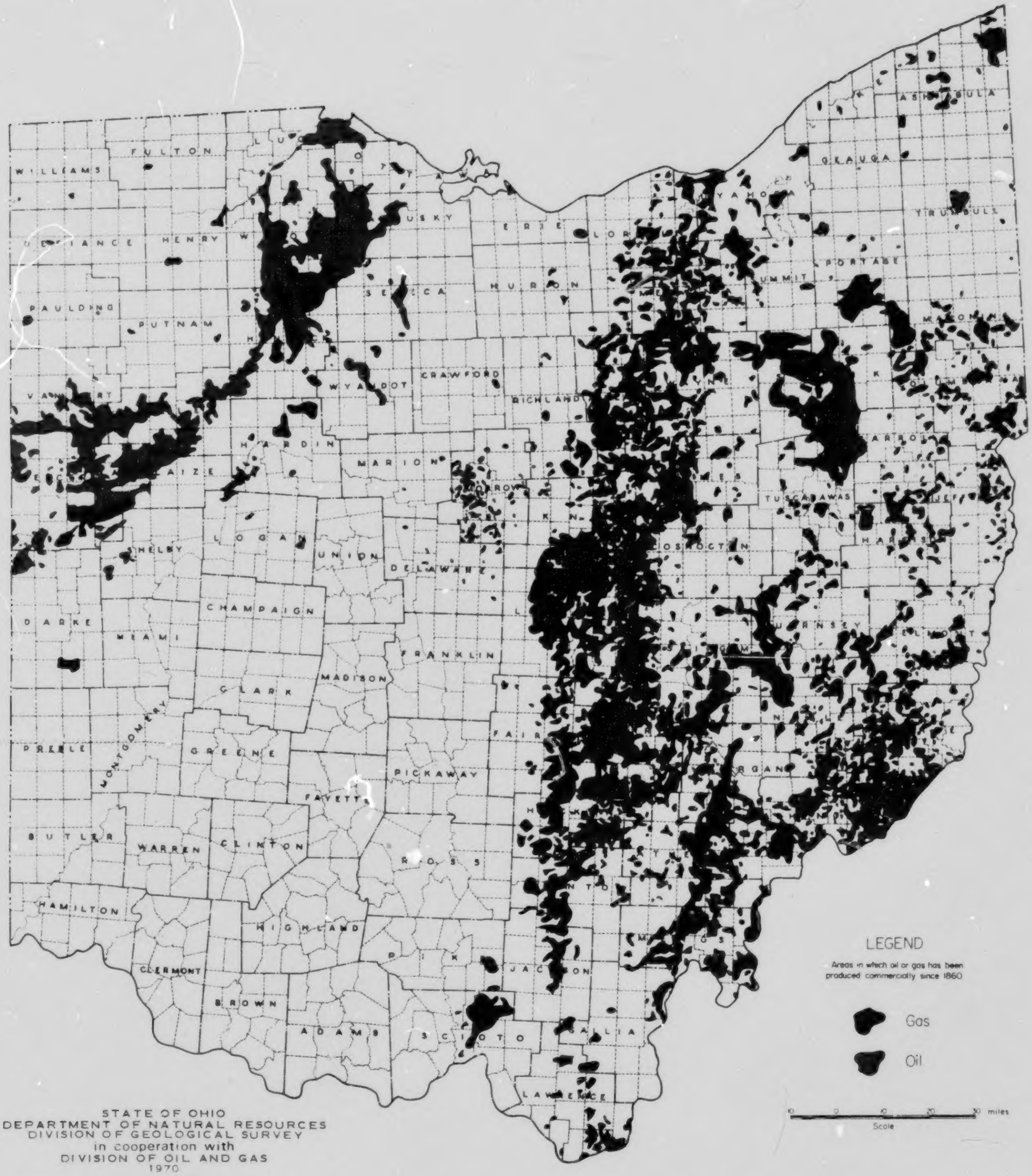
The relatively small quantity of gypsum produced in Ohio is used for the production of wallboard, lath, and gypsum plaster. Modern construction techniques make extensive use of wallboard, and most homes and apartments built in the last several years have interior walls of that material. The old-fashioned plaster of Paris casts used to immobilize broken arms and legs represent a minor use of gypsum.

Sandstone was formerly in much more demand for industrial use than it is at present; however, sandstone is quarried in Ohio and several important products are made from it. Small but significant quantities of high-purity sand and silica flour are used in the glass and pottery industry. Sandstone is produced also for homes, window sills, building decorations, patios, and walls. Sandstone pool table tops and chemical laboratory counter tops are made in Ohio. Many school chemistry laboratories are equipped with chemical and hot tops made from native Ohio stone.

The most important mineral fuel produced in Ohio is coal. Most of Ohio's coal is burned by power plants to produce steam, which in turn is used to produce electricity. The basic concept is conversion of the heat energy trapped in the coal into electrical energy, which can then be used for lighting, powering home and industrial appliances and equipment, and heating. A relatively minor tonnage of coal is still consumed for direct heating of homes and of certain types of plants and public institutions.

Natural gas is used largely for space heating and cooking and for other home and industrial applications such as fuel for hot water tanks, refrigerators, and air conditioners. Gas is utilized extensively in industry for processes requiring high, uniform, easily-regulated temperatures. Most ceramic products, for example, are now made in gas-fired kilns.

Oil is one of our most versatile natural resources and is readily converted into energy. Probably the commonest type is gasoline for automotive purposes.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ERIE
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PORTAGE
ASHTABULA
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CRAWFORD
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MONTGOMERY
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FAYETTE
BUTLER
WARREN
CLINTON
ROSS
HAMILTON
HIGHLAND
CLERMONT
BROWN
ADAMS
SCIOTO
JACKSON
GALLIA
LAWRENCE
LEGEND
Areas in which oil or gas has been produced commercially since 1860
Gas
Oil
10 0 10 20 30 miles
Scale

STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY
in cooperation with
DIVISION OF OIL AND GAS
1970

OIL AND GAS FIELDS MAP OF OHIO

Byproducts of gasoline refining include motor oil, grease, and other lubrication stocks. Kerosene for jet fuel and residual fuel oil for home heating are other important products. The list of chemicals, medicines, and agricultural and industrial products seems almost endless, running the gamut from food preservatives to floor wax.

Having looked briefly at the uses of native mineral resources, let us now consider the geographical and geological distribution of these resources and the relative tonnages produced for each commodity. On the accompanying geologic map the geographic distribution of current mining activity is shown by a symbol for each mineral commodity. The number within the symbol indicates the number of mining operations in 1971 for the county in which the symbol is plotted. For instance, a small circle indicates coal and the number four within it means there are four coal mines in a particular county.

Some production patterns are obvious: note, for instance, that coal mining is confined entirely to the eastern half of the state where rocks of Pennsylvanian and Permian ages are present. The carbonate rocks (limestone and dolomite) are most intensely exploited in western Ohio; this is in direct relationship to the thick Devonian-Silurian carbonate sequence which crops out or is under thin glacial drift in much of western Ohio. Sand and gravel production is limited to counties crossed by present-day drainage lines that were also major glacial outwash channels during Pleistocene time.

Clay production in western Ohio is limited to glacial lake clays; the clays of the eastern part of the state are the bedrock underclay variety. Bedrock clays and shales of Devonian through Pennsylvanian ages are extensively worked in eastern Ohio.

Evaporites (salt and gypsum) are produced only from Silurian-age rocks where they are close to the surface or within relatively easy reach by shaft or well.

Areas of oil and gas production are shown separately on the oil and gas fields map. It is important to realize that this map includes sites that have had commercial oil or gas production in the past and which are no longer productive. Most of northwestern Ohio, for instance, falls in this latter category.

Finally we answer the question "how much" in the way of minerals is produced in Ohio. Annual mineral production is of course related to the general business cycle. If business is generally good, construction will be up and so will production of the industrial minerals and mineral fuels. Conversely, if business is bad, unemployment high, and money in short supply, mineral production will slump.

The following table lists production for 1971, the last year for which full production statistics are available. (From the Ohio Division of Mines 1971 Report.)

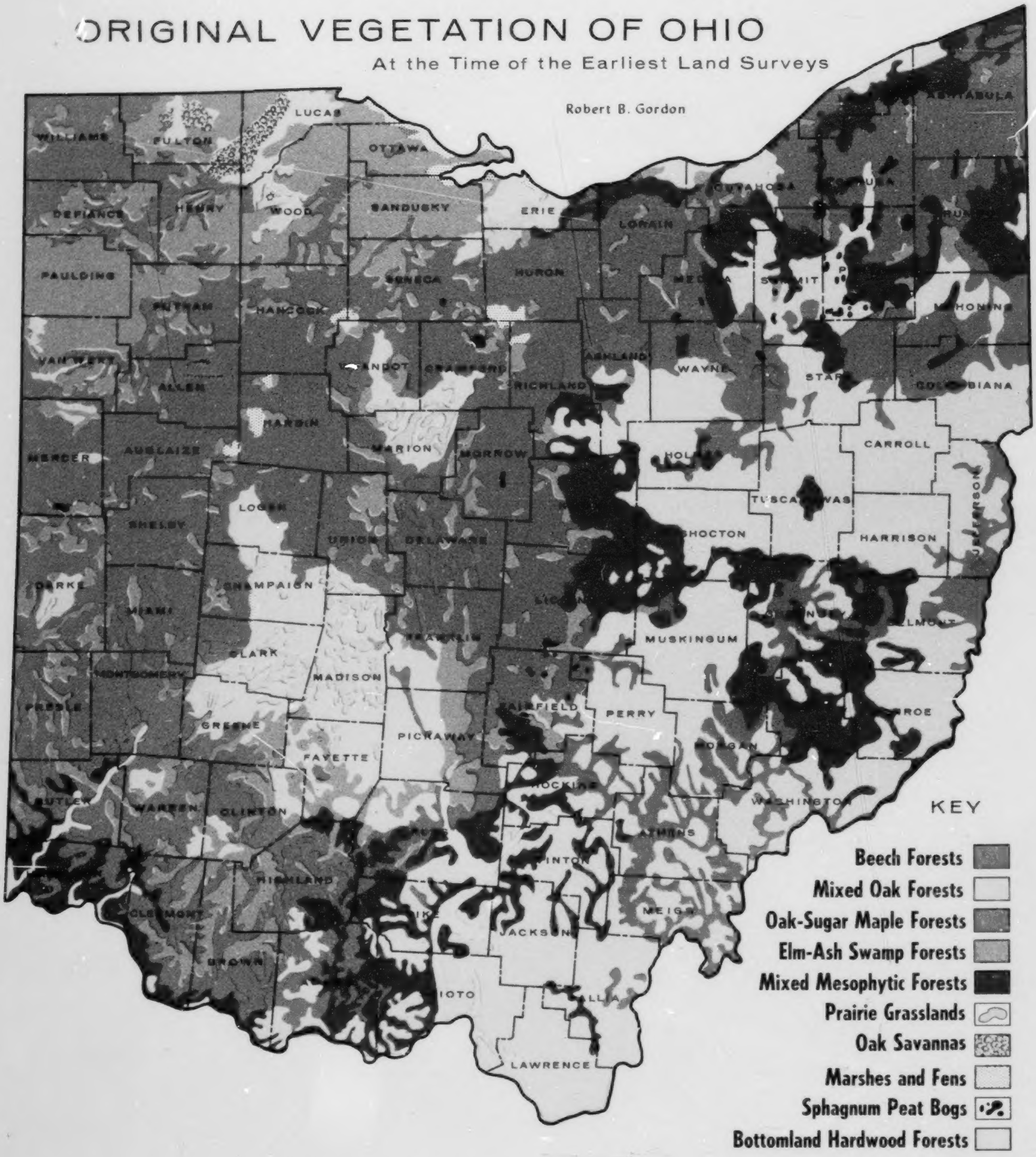
Commodity	Unit of production	Raw value
Coal	49,016,773 tons	$252,819,827
Limestone and dolomite	45,963,566 tons	72,151,000
Sand and gravel	42,918,898 tons	52,717,000
Salt	6,226,994 tons	50,961,000
Clay and shale	6,090,632 tons	11,244,000
Sandstone	2,257,322 tons	10,343,000
Gypsum	± 400,000 tons	1,349,000
Gas	82,677,746,000 cu. ft.	27,290,538
Oil	8,286,099 bbls.	29,800,062

Dr. Horace Collins, Chief
Division of Geological Survey
Ohio Department of Natural Resources

ORIGINAL VEGETATION OF OHIO

At the Time of the Earliest Land Surveys

Robert B. Gordon


WILLIAMS
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OTTAWA
DEFIANCE
HENRY
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ASHTABULA
TRUMBULL
LORAIN
MEDINA
SUMMIT
PORTAGE
MAHONING
PAULDING
PUTNAM
HANCOCK
SENECA
HURON
VAN WERT
ALLEN
WYANDOT
CRAWFORD
RICHLAND
ASHLAND
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COLUMBIANA
MERCER
AUGLAIZE
HARDIN
MARION
MORROW
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TUSCARAWAS
JEFFERSON
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DELAWARE
COSHOCTON
HARRISON
DARKE
MIAMI
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LICKING
GUERNSEY
BELMONT
CLARK
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MUSKINGUM
PREBLE
MONTGOMERY
GREENE
FAIRFIELD
PERRY
MONROE
PICKAWAY
FAYETTE
MORGAN
BUTLER
WARREN
CLINTON
HOCKING
WASHINGTON
ROSS
ATHENS
HIGHLAND
VINTON
CLERMONT
PIKE
MEIGS
JACKSON
BROWN
SCIOTO
GALLIA
ADAMS
LAWRENCE
KEY
Beech Forests
Mixed Oak Forests
Oak-Sugar Maple Forests
Elm-Ash Swamp Forests
Mixed Mesophytic Forests
Prairie Grasslands
Oak Savannas
Marshes and Fens
Sphagnum Peat Bogs
Bottomland Hardwood Forests

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NATURAL VEGETATION IN OHIO

The Ohio wilderness that confronted the white pioneers about 200 years ago was part of one of the most extensive and magnificent deciduous hardwood forests on earth. This forest stretched as an almost unbroken stand from the Appalachians to the Mississippi, from the Great Lakes to the Gulf of Mexico. It once was said, and probably quite accurately, that a squirrel could climb a tree on the Pennsylvania border and cross Ohio to the Indiana line without coming down out of the tree tops. Virtually all of Ohio, with the exception of its streams, a few lakes, and some small isolated patches of prairie, was forested. The forest composition, however, was not uniform over the state, as certain species dominated in some areas and were entirely absent in others. The variety of vegetation types was a reflection of variable habitats and was a product of complex environmental factors of which climate, soil, and topography were the most significant.

The Indians who had lived in this forest for centuries existed in virtual equilibrium with the environment. They only slightly modified the natural patterns which were responsible for the various vegetation types. Their lifestyle produced almost no ecological violence.

The hardwood forest is a poor producer of food for *Homo sapiens*. This coupled with other stresses kept the Indian population quite low, probably less than 10,000 in the entire state at the time of pioneer development. The pioneers soon learned that the land could produce considerable food if the trees were removed and also that certain vegetation types were good indicators of soil fertility and productivity. Beech forests, for example, generally grew on the deep fertile morainic soils. This proved to be a fatal association not only for many beech trees but also for the passenger pigeon which by the millions fed on the abundant supply of beech nuts from these widespread forests. Other animals such as bears, wolves, bison, deer, wild turkey, and beavers also were displaced with the demise of the forests and the subsequent ecological violence.

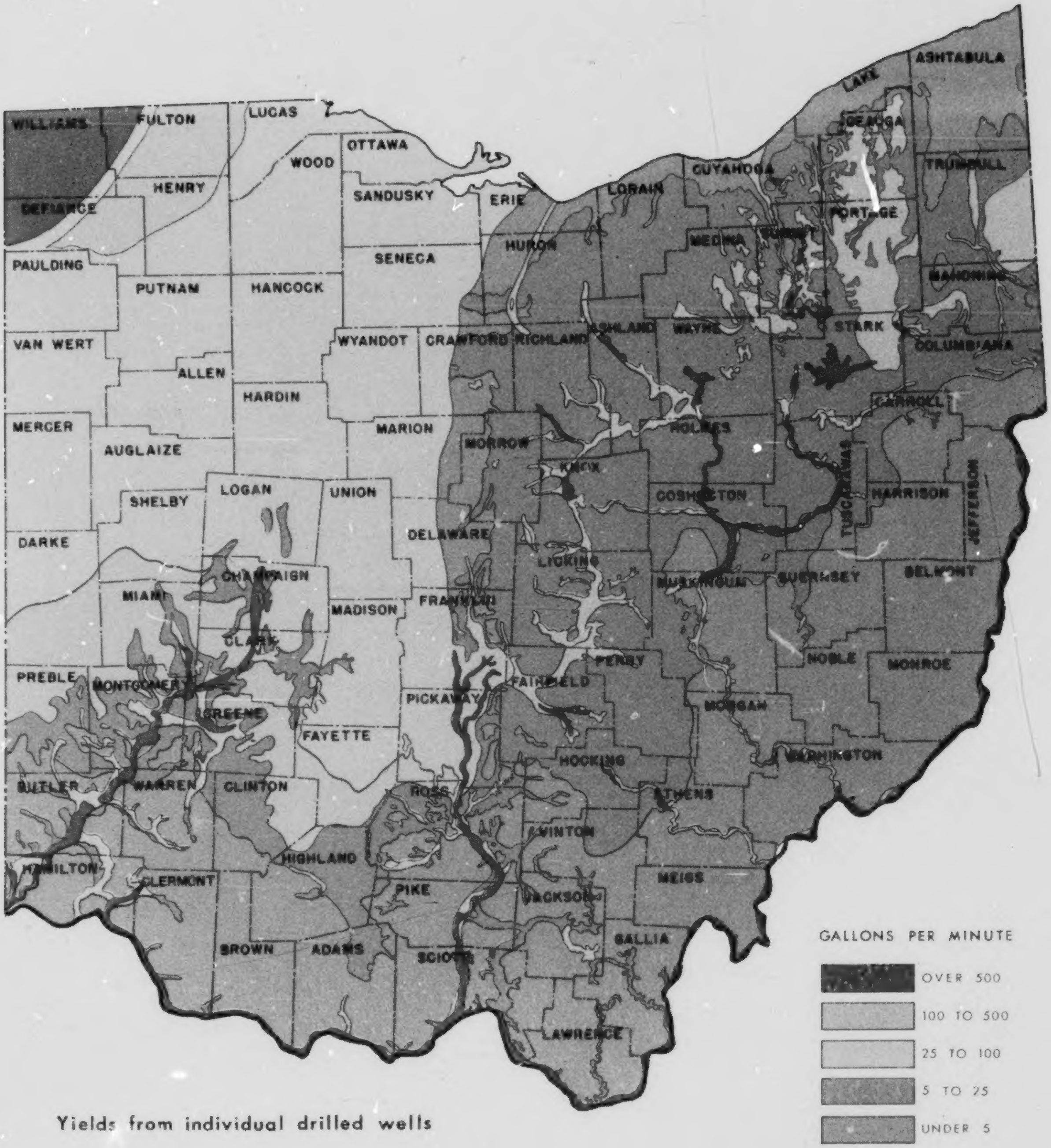
Some of the trees that were cut were used for buildings and fuel, but most of the forests were cleared for field crops and pasture. Many clearings were made as a defense against Indian attacks, as the Indians stubbornly resisted the encroachment into their territory and the modification of their forest environment.

The efforts at clearing have been so thorough that very few remnants of the once mighty Ohio forest are left. This is indeed unfortunate. We could have hoped that at least one township or even a section would have been preserved for future generations to observe, to study, or just to appreciate. Its worth now in terms of these values would be much greater than all the board feet or cash crops that such an area has produced. With more than 10,000,000 people presently living where less than 10,000 lived a short 200 years ago, we must develop sophisticated environmental management techniques to survive. Natural ecosystems provide the basic keys to these management procedures. As has been said, "Natural areas hold the answers to questions we have not yet learned how to ask." The small remnants of original or near-original vegetation that still exist take on tremendous significance and should be preserved and researched to provide answers to environmental dilemmas.

Plant communities will usually regenerate in a fairly predictable manner if the degree of modification to which the area has been subjected was not too severe. In certain areas, however (urban areas, stripmines, some agricultural areas, and some grossly polluted streams) the management procedures which society has employed are so severe that former patterns will never be reestablished. In either instance, it is of considerable worth to know what the general characteristics of the ecosystems were before significant modification by man.

The original vegetation types provide a better index to the potential of an area than does the existing vegetation, because the original types, which developed over long periods of time, represented a stable energy equilibrium between the species involved and the total of environmental factors such as climate, soil, and topography. Herein lies the value of recording the natural vegetation of Ohio in pioneer days.

Dr. Charles C. King, Executive Director
The Ohio Biological Survey
The Ohio State University


WILLIAMS
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MONROE
PREBLE
MONTGOMERY
GREENE
FAYETTE
PICKAWAY
FAIRFIELD
MORGAN
WASHINGTON
BUTLER
WARREN
CLINTON
ROSS
HOCKING
ATHENS
VINTON
MEIGS
HAMILTON
CLERMONT
HIGHLAND
PIKE
JACKSON
GALLIA
BROWN
ADAMS
SCIOTO
LAWRENCE
GALLONS PER MINUTE
OVER 500
100 TO 500
25 TO 100
5 TO 25
UNDER 5

Yields from individual drilled wells

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GROUND-WATER RESOURCES IN OHIO

OHIO DEPARTMENT OF NATURAL RESOURCES

OHIO'S WATER RESOURCES

Ohio receives an average of 38 inches of precipitation a year, with individual weather stations recording from 29 to 44 inches. It is fairly well distributed over the state and throughout the year, being generally higher in the southwestern part of Ohio and diminishing toward Lake Erie. October and February have the lowest monthly averages, 2.3 inches, while June has the highest average, 4.1 inches. Extremes in monthly precipitation have varied from zero to as much as 16 inches, resulting in periods of drought or flood.

Of the 38 inches of precipitation received annually, about 25 inches return to the atmosphere through evaporation from soil and plant transpiration (collectively referred to as evapotranspiration). The remaining 13 inches either run off in streamflow or percolate to groundwater storage.

Ohio has over 3,300 named streams and probably an equal number of unnamed tributaries. Their combined length approaches 44,000 miles, averaging roughly one mile of stream to each square mile of land area. About four-fifths of the state's stream mileage falls within the Ohio River drainage basin, while the remainder is in the Lake Erie drainage basin.

Ground water is water that is contained in the open spaces of the earth's materials. It is present in the pore spaces of sandstones, in joints and fractures of limestone, and between the grains of sand and gravel deposits. It is the water that supplies all wells and springs. Ground water keeps our streams and rivers flowing during dry periods.

There are more than 50,000 lakes, ponds and reservoirs in Ohio, nearly all of which were man made. The great majority of these, over 90 percent, are small ponds of less than two acres in size. Many state agencies, municipalities, conservancy districts and other public agencies have built lakes for such purposes as recreation, water supply, streamflow augmentation, and flood control. Some of the earliest state-owned lakes were built over 140 years ago to supply water to a network of canals constructed across Ohio. With the decline of the canal era, use of these lakes became largely recreational. Buckeye Lake, Grand Lake St. Marys, and Indian Lake are popular examples of former canal-feeder lakes. Examples of two recently-constructed state lakes are Salt Fork Reservoir (for recreation, water supply, flood control) and Killdeer Upground Reservoir (recreation, streamflow augmentation, irrigation).

The federal government has also been instrumental in building lakes in Ohio. Many flood control reservoirs have been built by the U. S. Army Corps of Engineers over the past 35 years. The state often participates in such projects for the development of recreational facilities. Burr Oak, Deer Creek, Delaware, Dillon, and Mosquito Creek lakes are examples of federal lakes around which the State of Ohio has developed recreation under agreements with the federal government.

There are also a large number of privately owned lakes and reservoirs in Ohio. Most numerous are the small farm ponds dotting the landscape, supplying water for wildlife and livestock.

The total amount of water used for all purposes in Ohio amounts to nearly 17 billion gallons per day. This represents almost 1,600 gallons per person per day.

About 75 percent of the total amount of water used in Ohio goes to electric power generating plants. Manufacturing processes use approximately 15 percent, while public supplies for domestic, commercial, and industrial uses constitute less than eight percent of the total. The remaining two percent represents non-urban usage for rural homes, livestock, recreation, and irrigation.

Ninety-five percent of all water used in Ohio comes from surface supplies such as lakes, streams, or reservoirs. Lake Erie and the Ohio River are important sources for water withdrawals, particularly for electric power generation. We should mention that most of the water used is not consumed, but ultimately returns to streams where it becomes available for further re-use.

Although ground water constitutes only about five percent of the total water used in Ohio, it is a very important source of supply, amounting to some 900 million gallons per day. More than seventy-five percent comes from sand and gravel deposits. Wells drilled into limestone and sandstone formations furnish approximately 160 million gallons per day. Approximately 78 percent of Ohio's municipal water supplies are served by wells. More than five million people—in other words, almost one-half of the state's population—depend upon ground water for their daily water needs. Ground water is indeed an important natural resource for Ohio.

Contrary to public opinion, water is not an unlimited resource. Too often wasted and misused, water makes the headlines only when we experience too little or too much — such as during conditions of drought or flood or when we discover that water has become useless to us because of pollution. Fortunately, recent trends indicate an increased public awareness and concern for our water resources. Recently enacted federal and state legislation are bringing about a concentrated effort to halt water pollution on a statewide basis.

Peter Finke
Division of Water
Ohio Department of Natural Resources

WILDLIFE IN WOODLANDS, WETLANDS AND WATER

Ohio's wildlife populations — both terrestrial and aquatic — depend upon man's management of the land, air, and water.

When the first European settlers arrived in Ohio, ninety percent or more of the state was covered by deciduous forest, with the rest in patches of prairie, swamp, and marshland. Woodland species of wildlife abounded. The timber wolf and mountain lion were common, the wild turkey resided in every county, and the mast-eating passenger pigeon was probably the most numerous of all birds.

Underground and surface water was abundant. Swamp forests, wet prairies, bogs, streams, and springs were wet year round. Because of heavy vegetative cover on the land, there was little erosion of soil into the waters, which consequently were clear with siltless bottoms. Before 1800, Ohio's larger streams supported huge populations of such game and food fishes as pike, walleye, sturgeon, and catfishes.

As settlement progressed, most of the forests were cleared for planting and grazing. In the unglaciated southeast hills, great tracts of hardwoods were harvested for charcoal to feed the local iron furnaces and to make way for cultivated crops and domesticated animals. In the northwest lake plain, hundreds of thousands of acres of swamp forest were drained and cleared for agriculture.

These land-use changes were accompanied by changes in fish and wildlife populations. The wild turkey, bobcat, and river otter practically disappeared from Ohio by 1900. Only a few white-tailed deer, creatures of the forest edge, remained by that date. The wolf and lion had departed earlier, probably forever. The passenger pigeon became extinct throughout its entire range. As the forests were removed, wildlife species of brush land and open land replaced the forest dwellers. Cottontail rabbits, bobwhite quail, and bluebirds spread into the openings. The fox squirrel and red fox usurped the domain of their woodland cousins, the gray squirrel and gray fox.

Changes also took place in the aquatic fauna. The ever-expanding ditches and drainageways not only eliminated directly many thousands of acres of water habitat, they also lowered the water table on surrounding lands, drying up some streams permanently and reducing others to only intermittent flow. In the last half of the Nineteenth Century, drainage converted the great Black Swamp of northwest Ohio from a cradle for the aquatic muskellunge and sturgeon to a planting bed for terrestrial farm crops.

During this period, too, the effluents of man's progress began to influence the inhabitants of Ohio's waters. Early pollutants were mainly sawdust and the leftovers from breweries and slaughterhouses. Later were added the wastes of cities and towns, industries, coal mines, and oil and gas wells. And, as the vegetation was stripped from the earth, silt was deposited on the bottom of streams and lakes in ever increasing amounts. Populations of many of the larger food and game fishes began to decline. By the beginning of the Twentieth Century, commercial fishing was prohibited for many of these species.

In the Twentieth Century, land use — and aquatic and terrestrial wildlife populations—have continued to change. In northwest Ohio the woodlots, fencerows, drainage ditches, and other "idle" areas have fallen steadily to the ax, plow, and dragline, leaving less and less habitat for wild creatures. Practices such as fall plowing and 'round-the-clock hay mowing during nesting seasons have reduced the value of farm land for the remaining wildlife. The exotic, once-plentiful pheasant is fast disappearing in this part of Ohio, and wetlands species such as the short-billed marsh wren and the eastern plains garter snake have become rare.

Broad, non-selective application of pesticides, excessive use of fertilizer, and inadvertent introduction of harmful metals such as lead, mercury, and cadmium into the ecosystem have also taken their toll of wildlife. The bald eagle, once a common nesting species in the Lake Erie marsh country, no longer lays viable eggs, probably because of the effects of pesticides on its body chemistry. Many fish and wildlife species have been found with unacceptably high levels of pesticides and metals in their bodies.

In our waters, nitrogen and phosphorous from fertilized fields and municipal sewers have fed plankton blooms which have so depleted the oxygen that many aquatic species can no longer thrive. Siltation from denuded lands is a major cause of fish population declines. Stream habitats are still being destroyed by cleaning, ditching, and straightening projects. The blue pike, once of considerable commercial value in the clear waters of Lake Erie, now faces extinction. Lesser known fishes such as the eastern sand darter and the river chub, both widespread at one time, are threatened with extirpation due to water turbidity and siltation.

However, some changes have benefited wildlife populations. In southeast Ohio, vast expanses of land were abandoned for farming, and have since been reclaimed by the mature forest. With the forest have returned the forest wildlife. Deer are again numerous in this region and, under wise harvest management, have reoccupied every county in the state. The wild turkey, reintroduced by the State Division of Wildlife in the 1950's, struts in the forests of one-fifth of Ohio's counties. Ruffed grouse are abundant in the hilly eastern woodlands, and the great horned owl and pileated woodpecker are increasing their numbers.

In spite of the loss of some species and the shrinking populations of others, Ohio, with its diverse habitat base, still supports a highly varied vertebrate fauna of more than 500 species. Many are restricted to particular geographic areas; others to highly specific habitat types. Each species has its own peculiar requirements. Some are migratory, and vary in abundance at different seasons.

Following is a list of *some* of the vertebrates that can be found, in suitable habitat, in nearly every part of Ohio.

Mammals: opossum, eastern mole, short-tailed shrew, little brown bat, big brown bat, raccoon, woodchuck, eastern chipmunk, fox squirrel, flying squirrel, prairie deer mouse, woodland deer mouse, cottontail rabbit, white-tailed deer.

Birds: wood duck, red-tailed hawk, bobwhite, killdeer, spotted sandpiper, mourning dove, yellow-billed cuckoo, downy woodpecker, great crested flycatcher, catbird, brown thrasher, robin, starling, red-eyed vireo, yellowthroat, house sparrow, chipping sparrow, field sparrow, song sparrow.

Reptiles: snapping turtle, midland painted turtle, eastern spiny softshell, northern water snake, green snake, northern brown snake, eastern garter snake, eastern ribbon snake, black rat snake, eastern milk snake.

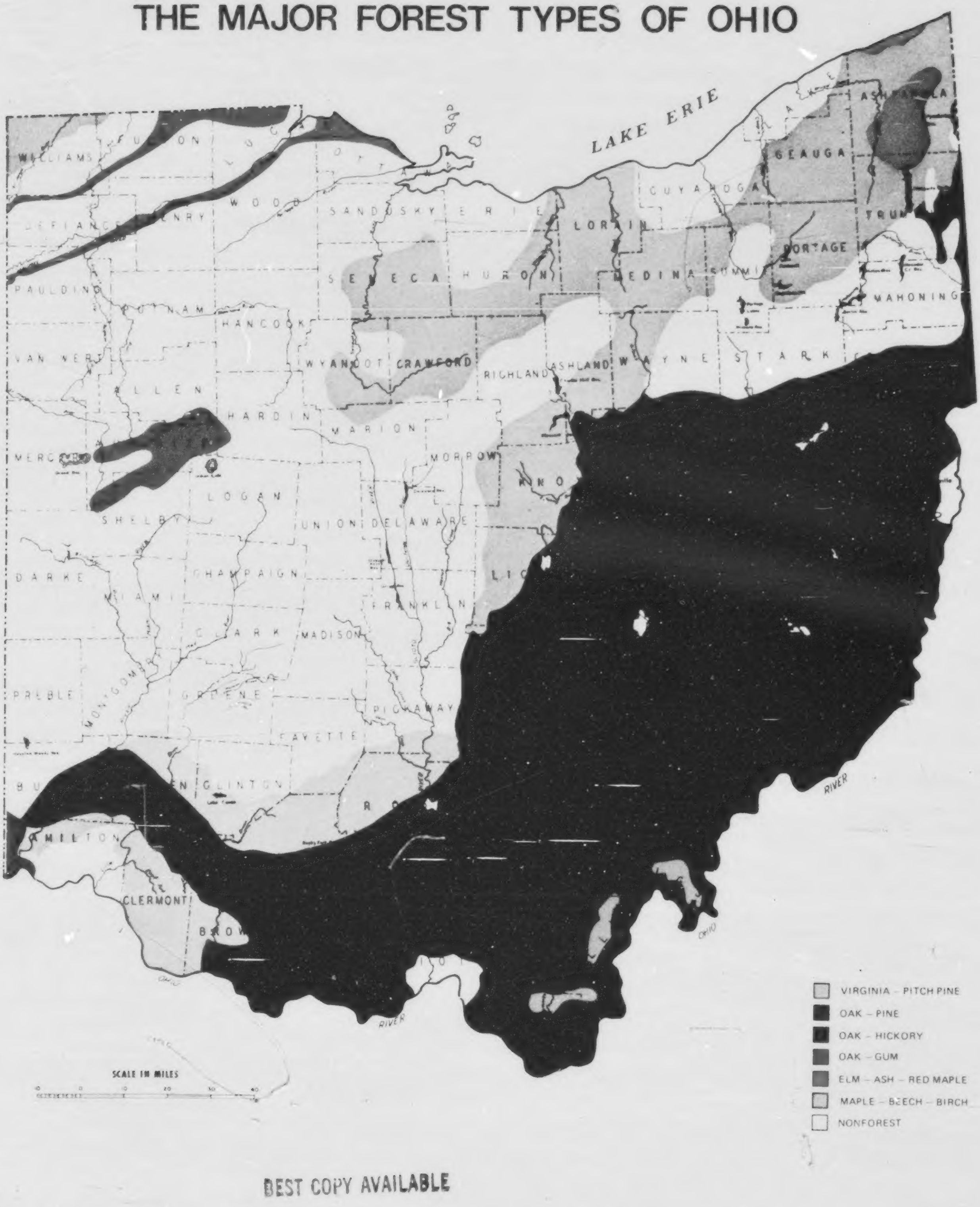
Amphibians: Jefferson salamander, spotted salamander, red-backed salamander, American toad, spring peeper, bullfrog, green frog, northern leopard frog.

Fishes: golden redhorse, white sucker, carp, common shiner, silverjaw minnow, bluntnose minnow, channel catfish, white crappie, rock bass, smallmouth bass, largemouth bass, green sunfish, bluegill, johnny darter.

Kenneth W. Laub, Technical Editor
Division of Wildlife
Ohio Department of Natural Resources

Raccoon

THE MAJOR FOREST TYPES OF OHIO


LAKE ERIE
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SANDUSKY
ERIE
LORAIN
CUYAHOGA
LAKE
GEAUGA
ASHTABULA
TRUMBULL
PORTAGE
SUMMIT
MEDINA
MAHONING
PAULDING
PUTNAM
HANCOCK
SENECA
HURON
VAN WERT
WYANDOT
CRAWFORD
RICHLAND
ASHLAND
WAYNE
STARK
ALLEN
HARDIN
MARION
MORROW
MERCER
AUGLAIZE
LOGAN
KNOX
SHELBY
UNION
DELAWARE
LICKING
DARKE
MIAMI
CHAMPAIGN
FRANKLIN
CLARK
MADISON
PREBLE
MONTGOMERY
GREENE
PICKAWAY
FAYETTE
BUTLER
CLINTON
ROSS
HAMILTON
CLERMONT
BROWN
OHIO RIVER
SCALE IN MILES
10 0 10 20 30 40
VIRGINIA - PITCH PINE
OAK - PINE
OAK - HICKORY
OAK - GUM
ELM - ASH - RED MAPLE
MAPLE - BEECH - BIRCH
NONFOREST

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THE FOREST ENVIRONMENT TODAY

At the time of settlement of Ohio, forests covered over ninety percent of the land area. In 1968, the forest area had been reduced to 6,329,200 acres, or 24% of the total land surface.

The following account by one Norris Birkbank describes some of the early timber.

"Yesterday, June 18, 1817, I measured a walnut almost seven feet in diameter, clean and straight as an arrow. The white oak is the glory of the upland forest. I measured a white oak by the roadside which at four feet from the ground was six feet in diameter, and at 75 feet it measured nine feet around. Before we entered on the flat country were some hills (near Chillicothe) covered with the grandest white oak, I suppose, in America. They measured 14 or 15 feet in circumference, their straight stems rising without a branch to 75 or 80 feet — thousands of them."

The forests of Ohio are generally divided into two physiographic regions. These two regions are the hill country or unglaciated region which covers the southeastern one-third of the state and the glaciated region which covers the remainder of the state. The hill country contains most of Ohio's commercial forest land, some 4,381,300 acres, compared to the 1,947,900 acres of commercial forest in the glaciated region. Approximately one-third of the state's land area contains about two-thirds of the commercial forest area.

The typical forest in Ohio today is a hardwood forest which contains a large number of different kinds of deciduous trees. In general, these trees have broad leaves which fall from the trees during the winter months. Hardwood forest types cover nearly 96 percent of our forest land with various coniferous trees covering the remainder of the forest land. In the natural forests of Ohio, some kinds of trees grow in association with other kinds of trees, with all being adapted to a similar set of environmental conditions. Forest biologists describe such natural associations as forest types. The most important forest type is oak-hickory which covers about 2,953,800 acres or about 47 percent of our forest land. The second most extensive forest type is the elm-ash-cottonwood type which covers 1,376,000 acres or 22 percent of the forest area. The elm-ash-cottonwood type is a wet habitat type. In third place is the maple-beech type at 1,151,600 acres. This type is usually found on deep, fertile, well-drained soils and contains many valuable timber trees such as sugar maple, black cherry, black walnut, red oak and white ash. From a timber standpoint, beech is not a valuable tree, but it is valuable as a source of food (nuts) and shelter (hollow trees) for wildlife.

During the first 150 years of man's association with the Ohio forest resource, most of the emphasis was placed on the production of lumber, veneer, pulpwood, cooperage, piling, poles, posts and many other timber products. Timber products will continue to receive strong emphasis in forest management because the forest is one of the few *renewable* natural resources that we have. It is quite different from nonrenewable natural resources such as coal, oil and gas.

Ohioans now realize that forests are a very important part of their environment and demand more from their forest resources than timber production alone. It is now recognized that forests are essential for wildlife habitat, outdoor recreation, aesthetic appeal, soil erosion control and water supply (the hydrologic cycle). It is increasingly recognized that forests screen dust from the air, assist in control of noise, have a moderating effect on air temperature, reduce wind velocity (windbreaks), warn of polluted air (effect of ozone and sulfur dioxide on eastern white pine) and may play an important role in maintaining the supply and balance of carbon dioxide and oxygen in the air we breathe.

Through careful management, Ohio forests can yield countless products for man's use and make a highly significant contribution to environmental quality at the same time.

A comparison of the present forest map with the original vegetation map of Ohio will support a relationship between the forests of pioneer days and the reforestation process going on at present.

William F. Cowen, Jr., Professor of Forestry
The Ohio State University
The School of Natural Resources
Chairman, The Ohio Forestry Camps

NATURAL AREA PRESERVATION

Ohio was born of deposits at the bottom of inland seas, coastal marshes and river deltas, and shaped by upheaval of the land, dissection by mighty rivers and streams and the gouging and scraping of glaciers. The rich and varied biota that is Ohio's natural heritage owes its existence to the influence of changing climates and natural migration routes for plants and animals from all directions.

At the start of the settlement of Ohio by European white man, the majority of the land was covered by hardwood forest. However, scattered across the state were a number of unusual natural communities that were relicts of earlier times. Perpetuated by microclimatic conditions were patches of tall grass prairies, fens, bogs, swamps and marshes disjunct from similar natural communities on the continent by hundreds or thousands of miles.

In the onrush of settlement that has made Ohio sixth among the states in population though only thirty-fifth in size, many of these unique natural communities have been eliminated. Yet remnants of this natural heritage do remain relatively unscathed by the advance of civilization. These are broadly referred to as "natural areas" and during recent years there has been a steady growth in the understanding of their importance and the realization that they should be preserved and protected.

Any outdoor site that contains an unusual biological, geological or scenic feature or else illustrates common principles of ecology uncommonly well is considered a natural area. The latitude of this definition allows for inclusion of areas with unique aquatic or terrestrial biota and areas ranging from those with unusual scientific value to those whose main reason for preservation is aesthetic. Though it is tempting to say that an area's unique natural history is reason enough that it should be preserved, the truth is that were it not for man's habitation of the land, natural area preservation would be unneeded. Thus, the justification for natural area preservation must include benefit to man. Natural areas are being used as outdoor laboratories for basic and applied scientific research. They serve as places for a variety of cultural and educational programs including those generally referred to as "interpretive," with nature centers enhancing their usefulness in reaching both youngsters and adults. Natural areas also provide refuge for populations of both common and rare and endangered species of animals and plants, not only for their intrinsic scientific and human interest but for their potentially valuable gene pool. Important to man's search for knowledge of his environment is the preservation in natural areas of entire ecosystems.

In Ohio, natural area preservation has taken many forms. Though only in this century has there been any organized effort to save such areas, many do exist today because of earlier efforts of man. Families who by tradition left a small parcel of woods uncut through the years have left us our only samples of "virgin forest." A peat bog set afloat in a reservoir completed in 1830 to provide water for the Ohio and Erie Canal probably remained unspoiled only because of its isolation as an island in a state lake. Preservation of sites of archaeological significance followed the establishment in 1885 of the Ohio Archaeological and Historical Society. The preservation of Blackhand sandstone gorges of the Hocking Hills area with boreal relict plants resulted primarily because of the establishment in the 1920's of the Division of Forestry of the Ohio Agricultural Experiment Station.

Preservation of the wet prairies of Wyandot County and the Lake Erie Marshes was initiated in the early 1950's after the establishment of the Department of Natural Resources. In 1959 the Ohio Chapter of The Nature Conservancy was formed, and during the decade that followed this organization was able to acquire or convince others to acquire and protect nearly two dozen outstanding natural areas. It also provided leadership and direction to the movement that led to the enactment in 1970 of Ohio's Natural Areas Law. The majority of the members of the Ohio Natural Areas Council created by that legislation are trustees of the Nature Conservancy. With a full-time executive director, it continues working to save natural areas, often in close association with the natural area and scenic river planning section of the Ohio Department of Natural Resources. The organization also serves effectively as a watchdog over all known natural areas within the state, doing battle, when necessary, with those who would attempt to encroach upon them with highways, housing developments, pipelines or sewers.

Often in the past the acquisition of an area as a nature preserve by a private individual or organization has meant that the area was closed to the public. This is usually not the case when a natural area is acquired by The Nature Conservancy or the Department of Natural Resources. It is, however, necessary to determine what the impact of public visitation will be for each area and then to establish rules and regulations that will assure its continued preservation. In the case of an extremely fragile ecosystem such as a bog, this may mean restricting visitation to use by permits only. In other areas, the only restriction may be on the use of motorized vehicles, pets, and firearms. The state classifies its preserves as scientific, interpretive or scenic and has rules and regulations for appropriate use.

Concern for the preservation of natural areas is a part of the growing realization of the relationships of mankind to the other living things that have evolved with him on earth. It is also an indication of the changing ideas as to what constitutes a quality life and an important part of the development of a culture-wide environmental ethic that can assure human life on earth in the millenniums to follow. As Dr. Kenneth Hunt, one of the pioneers of natural area preservation in Ohio, has put it, "We preserve natural areas not out of sentimentality, but to serve present and future human needs."

Ralph E. Ramey, Director,
Glen Helen Outdoor Education Center
Antioch College, Yellow Springs,
previously with Columbus Metropolitan Parks
and the Ohio Department of Natural Resources

Clifton Gorge

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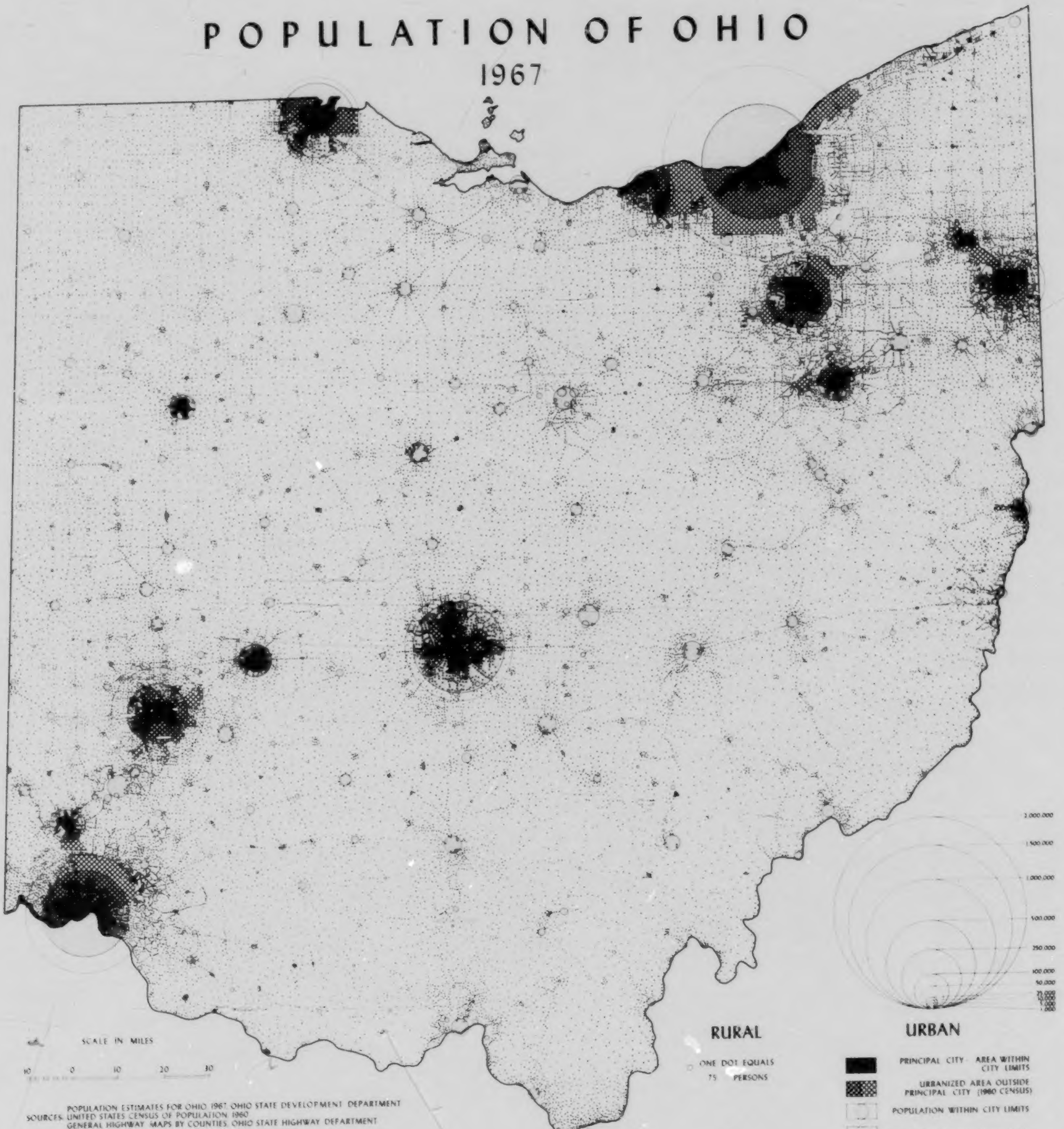
POPULATION OF OHIO

1967


SCALE IN MILES
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RURAL
ONE DOT EQUALS
75 PERSONS
URBAN
PRINCIPAL CITY - AREA WITHIN CITY LIMITS
URBANIZED AREA OUTSIDE PRINCIPAL CITY (1960 CENSUS)
POPULATION WITHIN CITY LIMITS
POPULATION OF URBANIZED AREA

SOURCES: POPULATION ESTIMATES FOR OHIO 1967, OHIO STATE DEVELOPMENT DEPARTMENT
UNITED STATES CENSUS OF POPULATION 1960
GENERAL HIGHWAY MAPS BY COUNTIES, OHIO STATE HIGHWAY DEPARTMENT

MAN'S IMPACT ON HIS ENVIRONMENT

The preceding profiles have described the original natural environment of Ohio noting some of the changes that have taken place. The roots of environmental change go deeply into the history of settlement, and one must understand at least the broad sweeps of history as well as the needs and desires of the people of the state in order to understand environmental changes and alterations of the environment that have taken place.

Stone fragments and bones of individuals found in glacial terraces in a number of places in Ohio indicate primitive man lived here when the terraces were deposited. Certainly there is no present evidence of landscape modification by these people and we know nothing of their influence upon Ohio's environment. The relationship, if any, that existed between the "glacial" or "paleolithic" men and the mound builders is unknown.

A group or groups of people called the Mound Builders have left their mark upon the landscape of Ohio. There are over 3,000 known mounds in Ohio. These range from very small mounds to some that are quite large. They were constructed in a great variety of shapes: circles at Circleville; squares, rectangles, crosses such as Tarleton Cross, and snake-like as Serpent Mound. In addition, forts composed of both stone and earth were built by these people.

Where did these people come from? Are they ancestral to the American Indian? What were their numbers? Religion? Agricultural development? Communication system, if any? Or societal organization? Were they all of one race and of one period? There is much literature about them and many conjectures have been made by archeologists and anthropologists to answer the questions presented here. We do know that they were found in many parts of Ohio, of the United States, and in other parts of the world. It is believed that they have had very little influence upon the environment which was seen by the European settler except for the mounds and forts that have been left behind and are so evident upon the landscape today, even though many have been destroyed in the process of settlement and development.

Most Ohioans have read of frontier troubles with the Indians and of the Indian wars in Ohio. However, it might be surprising to learn that in 1700 there were no major tribes living in Ohio. There were some Indians who hunted here but very few permanently lived on the land that was to become Ohio. This does not mean that Indians had not occupied this land at earlier times; in fact a tribe of Erie Indians had been in the area previous to this and had been defeated and dispersed by the Iroquois. Most of the tribes known by the early settlers had migrated into Ohio after 1700 because of pressures of settlement in other parts of eastern United States or were enticed here because goods could be obtained from British traders more cheaply than from the French traders. For example, the home area of the Miami Indians was in Indiana in the Wabash-Maumee River basin region. They moved to the upper portion of the Great Miami River to be nearer the English traders. The Shawnees were originally in South Carolina and through settlement pressures and difficulties from other tribes moved to eastern Pennsylvania, then to western Pennsylvania, and then to the Scioto valley area. The Wyandots, who had lived on the north shore of Lake Erie (Canada), gradually moved west and south to occupy lands in what is now northwestern Ohio. The same applies to many tribes or Indian groups.

The significance of this is not what tribes were found in Ohio but rather that their occupation of the land was not over a long period of time. Many of these tribes did practice agriculture but it was not the same as that practiced by the European settlement. Unlike the Europeans, the Indians did not clear large areas for agriculture but practiced agriculture in areas already devoid of forest, such as meadow sites along rivers or where natural fires had made a clearing. In addition, the total number of people involved in this activity was relatively small.

Without the factor of trade, the Indians with their small numbers had very little influence on the wildlife populations because the biotic potential of wildlife was greater than their kill. In other words the wildlife populations were rather static. However, with the coming of the fur traders, definite inroads into the population of these animals were made. To obtain from the traders guns, powder, traps, and many other goods they desired, the Indians increased their slaughter of wildlife. Weapons were now superior to those used previously and incentives other than basic needs for food, clothing, and shelter had been provided. One could say that landscape modification had begun by European influence even though active settlement by Europeans had not. However, this modification was certainly minor compared to what was to take place with settlement of the land by people of European descent.

Ohio was the first state to be settled in the Northwest Territory. For over 200 years the European settlers were kept to the eastern seaboard by the Indians and by claims of ownership of the lands to the west by England, France, and Spain.

Once the movement into the new lands to the west started, the settlers began to modify the landscape. A large majority of these people were farmers and this meant that large areas of forests had to be cleared for agricultural crops. Some of the wood was used for farmstead buildings but a considerable amount was burned because of a lack of market in the area and a poor transportation system to export the timber from the region. It is indeed fortunate that in the first 100 years of settlement wood was needed for fences and for fuel for heating and cooking. As a result many farmers maintained a woodlot of at least three to ten acres for this purpose. While these woodlots are not virgin forests, they do comprise a fair share of Ohio's forest land today found outside the southeastern area.

With the forest removal, even though some areas were retained, there came a change of wildlife in the area. Larger animals that needed large forest areas could no longer exist in the ecological change that had taken place. Conversely, animals that do well on a combination of forest and agricultural lands thrived and their populations increased.

The agricultural lands, particularly in the Scioto and Miami River valleys and the Lake Erie plain, were excellent and crop yields were high. Much of the farming in northeastern United States east of the Appalachians had been subsistence farming, but Ohio agriculture did produce considerable surplus. The farmer's desire to sell his surplus products led to the development of manufacturing to process the raw material and transportation to carry the manufactured product to market. Thus, there was additional change to the landscape or environment as villages, towns, and cities developed and transportation routes were established.

In the very early days cattle and hogs were driven from the Miami valley farms to the eastern seaboard region and arrived there in very poor condition. Meat processing was needed. Hams, lard, tallow, and smoked meats were the first to be produced and Middletown and Cincinnati vied for the title "Porkopolis" of the world. Grains were processed into alcoholic beverages.

Hams, candles made from tallow, soap from fats and alcohol from grains needed transportation to market as well as large quantities of unprocessed farm products. This led to the development of roads. These took many forms. Dirt roads were very muddy in rainy weather. Corduroy roads where logs were buried gave a bumpy surface but resulted in much less mud. Finally, roads were covered with a gravel surface. The first major route was Zane's Trace extending from Portsmouth to Wheeling. The Trace aided in the settlement and development of southeastern Ohio. The National Road — a part of which became U.S. 40 and which I-70 closely parallels today — was even more significant because it connected the east and west ends of the state. While roads were important in internal travel and the National Road did permit some exportation of products from the area, these early roads were not satisfactory for large movement of goods. Road building further modified the landscape, creating changes in the environment and encouraging further settlement.

The success of the Erie Canal through New York State inspired Ohioans to create canal links from the Ohio River to Lake Erie. While this was a considerable engineering job for its day, the glaciers had prepared relatively easy routes — glacial spillways — for it. The glaciers had blocked the St. Lawrence River which flows north to drain the Great Lakes to the ocean. The glacial melt waters had to flow to the south cutting wide passageways through the line of hills between the Ohio River and the Great Lakes drainage. It was in a number of these spillways that the canals were built. Although several canals were built with feeders (branches), there were two major canals. One, the Miami-Ohio Canal, went from Cincinnati on the Ohio River to Toledo on Lake Erie. This canal used the Mill Creek Valley to reach the Miami River and then ran along the Miami for many miles before it cut across country to the Maumee River and Toledo. Grand Lake or Lake St. Marys and Indian Lake were constructed in the low divide to provide water for the canals. The second canal, the Ohio and Erie, went from Portsmouth up the Scioto River and then through numerous valleys to connect with Lake Erie at a sleepy little village called Cleaveland (later Cleveland). Buckeye Lake, between Newark and Lancaster, was built to provide water for this canal. The canal systems were completed by 1845 and gave Ohio over 900 miles of inland waterways. The canals and lakes left an indelible imprint upon the landscape. Some of the canals and locks are still with us, some were filled in to provide roads, and there are proposals to use the remaining lands as parks, open space, and bicycle and hiking trails.

Many of the canals were very soon paralleled by railroads even before they were completed, so they rapidly became unimportant, although they did provide the first early, cheap transportation system. Products could be manufactured and shipped from the interior of the state to New Orleans and New York and from these centers on to world markets. Other manufactured goods could be imported at a much cheaper price. The canals further encouraged manufacturing in Ohio as well as growth of urban areas.

The first railroad entirely within Ohio was constructed in 1839 from Sandusky to Bellevue and was later extended to Springfield and Cincinnati. In 1848 another railroad was constructed from Cleveland south to Columbus and Cincinnati. As noted previously these lines paralleled the canals and industry within these cities continued to grow.

As the population increased there was a continued demand for farm land. In the northwest there was an extensive area of old glacial lake plain which was poorly drained; a large section of this was called the Black Swamp. These poorly drained lands teemed with wildlife, particularly waterfowl. Man gradually encroached upon this land with a number of drainage projects creating some of the best farmland in Ohio but drastically changing the natural wilderness. Today, the land in this area is dotted with many farms and drainage ditches.

Many of the farmers who had settled in the hill lands of southeastern Ohio and the morainic hills in other sections of the state came from flatland country of eastern United States and Europe. When the forests were removed, the virgin soils were quite fertile, but most of these farmers tried to farm the land as though it was flat land. The land was exposed to the beating power of the rain, and lacking the roots of natural vegetation to hold it in place, it became badly eroded. Many of these farms became unproductive and were abandoned because of a lack of knowledge of how to farm hillslopes. The Soil Conservation Service at a much later date (starting in 1941 in Ohio) managed to encourage good hill land farming techniques so that farms in this section are improving. A flight over these areas shows contour plowing, stripcropping, terraces, and diversion channels as important parts of the landscape. All of these are farming techniques to control the direction and speed of runoff water to reduce soil erosion and to help maintain or increase productivity of the land.

Labor was needed for public works — the building of canals, railroads, and roads — and by expanding industry. Early settlers were migrants from farms in other states. German, Swiss, Scotch-Irish and English were the dominant ethnic peoples in this group. After the Civil War the United States reached full flower as a country that had accepted the Industrial Revolution. In the industrial expansion after the Civil War, while labor increasingly came from Europe, a large part came from another farm surplus crop — children. After World War I an important source of labor was the migrants from Appalachia, especially from Kentucky, Tennessee, and West Virginia.

Early manufacturing had been the processing of local raw materials, especially farm products. Along the Ohio River, in the Mahoning Valley, and in some other localities in eastern and southeastern Ohio, small deposits of low grade iron ore led to an iron industry utilizing charcoal as a source of carbon in the reduction of the ore. The demand for charcoal led to further forest depletion, especially in hilly southeastern Ohio. After the Civil War, high grade iron ore was imported from the upper Great Lakes and married to Ohio and Pennsylvania coal for a burgeoning iron and steel industry.

While agriculture and forestry are still significant, Ohio is a manufacturing state which ranks fourth in the United States in people employed in manufacturing. As previously noted, the early industries were based on processing local raw materials. As the nation expanded to the west, some of these industries continued but other types developed. Today, Ohio is significant in the manufacturing of primary metals (particularly iron and steel), machinery (both electrical and non-electrical), transportation equipment, fabricated metal products, rubber and miscellaneous plastic products, chemicals and allied products, and stone, clay, and glass products, to name a few.

Industrialization and urbanization have made a drastic change in Ohio's total flora and fauna, causing many species to disappear. On the other hand some species of flora and fauna are now found in Ohio that were not here originally. These are exotics that have been introduced by man. Some of the introductions have been beneficial but some are detrimental to man's well-being.

An industrialized society with a high standard of living needs great quantities of energy. The demand for electrical energy alone in Ohio has doubled each decade for the last four decades and it is anticipated that this rate will continue. Ohio has little waterpower but it does have mineral fuels so necessary for energy production and chemical products. It has a long history of oil and gas mining, but today its production of these mineral fuels is less than one per cent of the total production of the United States. Coal is much more important, and Ohio ranks fifth in the nation in coal mining, with about nine per cent of the coal production of the United States.

Ohio's coal is found in relatively horizontal layers with a slight dip of the strata to the east. Most of it is in the hilly section of eastern Ohio. The early coal mining technique was the drift method. Miners dug into the side of a hill, mining rooms of coal and leaving pillars and walls of coal to support the rock roof. In the last 25 years, strip mining has gradually replaced the old room and pillar method of mining; today over one-half of Ohio's coal is mined by this method. This technique removes more coal from the ground more cheaply than the old method. In addition, thinner beds of coal lying above larger beds can be mined that could not be economically mined before.

In strip mining, large machines such as the "Silver Spade" (scoop shovel) and the "Big Muskie" (drag shovel) are used to remove the rock layers which have been blasted loose above the coal. Smaller shovels then come to remove the coal itself. The rock that has been removed is dumped into large piles. When a second cut along the hill is made, then the rock from this cut is piled into the first cut, and this continues until all the coal in the hill is removed. At times the rock above is too deep to be moved economically even with these mammoth machines so that mining cannot continue.

Although strip mining removes more coal from the ground at less cost than other methods of mining it causes great damage to the surface of the earth. In the past many mining companies left these big piles of rocks that would not be usable by man for centuries. Water with a high acid content drained from them and erosion from their surface together with water runoff was great. The destruction of the environment in these areas was almost complete.

Ohio has had a strip mine reclamation law since 1955 and a strong one since 1972. Under this new law, the "high wall" (caused when a hill can no longer be mined, leaving a verticle rock escarpment) cannot be left because the land has to be returned to its original slope or to less than the original slope. The topsoil (if there is any) is to be removed before mining and then put back on the land after the mining and grading are done. This must then be sown to grass to prevent erosion. Later the company can plant trees or other vegetation if it wishes. In some reclamation projects the land is actually better than it was before mining. Unfortunately, many old areas still remain to be reclaimed and in many places strip mining has produced a highly acid condition that makes the surface difficult to replant. Coal mining is needed, but reclamation is the theme. Reclaimed strip coal areas are being used for recreation, grazing cattle, forestry, and wildlife preserves.

In 1913 catastrophe struck Ohio which led directly and indirectly to great changes in Ohio's landscape. After a number of days of very heavy rain, floods came to the three major valleys—Muskingum, Scioto, and Miami. The Miami in southwestern Ohio has always had great fluctuation of flow particularly because of the clay soils in the area. Rainwater does not readily penetrate these soils, so the runoff to the streams is almost immediate and great. While damage occurred in all three valleys, it was particularly great in the Miami valley where the cities of Piqua, Troy, Dayton, Miamisburg, Franklin, Middletown and Hamilton are located. These cities with their considerable industry were located largely in the flood plain areas, which was designed by nature to take care of the excess water that rivers must sometimes carry. Damage was particularly great in Dayton, which is located at the confluence of three rivers and in their flood plains.

The 1913 flood caused over $100,000,000 of property damage and 300 lives were lost. In their concern for future flooding, the people of the Miami valley devised a flood control plan and asked the state legislature to pass the Conservancy District Act. This was a new approach to the problem and one of Ohio's contributions to the world. It created a new social institution—a form of government—for flood control. The engineering features of the plan called for snag removal, larger bridges, channel improvements, and some levees in city areas, but its main emphasis was on five large dry dams. Today the area behind these dams is either in farmland or in parks. The people of the Miami valley paid for their flood control project on the basis of benefits derived.

As a result of the Miami experience, the Muskingum River flood control project was later devised with the financial help of the federal government. The Muskingum is the most extensive river system in the state, draining almost one third of Ohio. While the engineering features of the plan did call for a few dry dams, the great majority of the flood control dams created storage reservoirs having permanent pools or lakes. Some of the lakes that were created are Atwood, Tappan, Clendening, Piedmont, Wills Creek, and Senecaville Reservoirs. Thus, new ecological conditions were created and the lakes provided recreation for water-related activities. The Muskingum Conservancy District has also been active in a reforestation program, and much of the old, worn out farm land adjacent to the lakes has been put back into forests. Many naturalists commend the district for excellent management of the environment.

In the Scioto Valley, Hoover, Delaware, and O'-Shaughnessy lakes were built for flood control and water supply, especially for the city of Columbus. In northeastern Ohio, Pymatuming, Berlin, Meander Creek, and Mosquito Creek Reservoirs have been built for flood control, water supply, and low water flow augmentation. Of course, once reservoirs are created, these become recreation sites. While Ohio had a few small natural lakes, it had no large lakes. All of these that are a part of the landscape today represent man's modification of the environment.

Water supply, so important to man's existence, has many sources. The communities along Lake Erie are dependent upon the lake for most of their water. Many cities and towns use rivers adjacent to them for their supply. While many of these rivers have months of very high water, they also have months of very low flow. As cities increased in size along streams having this fluctuation in flow, the water supply problem of low water periods had to be solved. This was done by creating large reservoirs such as the Hoover Reservoir for Columbus. Communities along the Ohio River frequently use its water for their supply. The building of dams on the Ohio River by the federal government to improve navigation changed the river level considerably so that there are large, deep pools of water. The river is also, now, much wider that it was prior to the dam building.

In some areas of Ohio, especially in the southeast and southwest, ground water is important for water supply. The sandstones of the southeast are particularly good aquifers. In the southwest the bedrock is composed of limestones and shales which are very poor aquifers. The ground water supply in that area comes from valleys buried in glacial debris. So far the buried valleys have been able to meet most of the needs of the many urban agglomerations in that area. However, the farms on the uplands have had a history of water shortage in the summer for livestock drinking water. Since the bedrock here is a poor aquifer most wells were drilled to the base of the bedrock and glacial till. These wells went dry in summer. An environmental response to this basic need is the building of a great number of farm ponds. As one flies over the land today in Ohio, one can see thousands of farm ponds glistening in the sunlight making an irregular pattern upon the landscape. In addition to the small farm ponds, the area in eastern Ohio also has had a great number of small lakes or ponds created by strip mining reclamation practices. More recent creations on the landscape are the many "borrow pits" formed to provide fill to elevate superhighways over roadways and railroads.

The story of landscape modification is directly related to numbers of people and their level of living. Ohio's population has grown from 230,760 in 1810 (seven years after it became a state) to 10,652,017 people in 1970. In 1810 only a little over one per cent of the population lived in urban centers, but in 1970 over 75 per cent resided in urban agglomerations. The change in the population density per square mile has increased from nearly seven in 1810 to over 263 per square mile in 1970.

In Ohio's early decades, the percentage population changes were quite high, but the largest growth in any one decade was from 1950 to 1960, when more than one and three quarter million people were added to the population. From 1940 to 1970, the number of people added to Ohio's population was equivalent to the state's entire population in 1890.

With the exception of one decade, urban population growth steadily increased throughout Ohio's history. Initially there were scattered settlements with poor communication and transportation. With advancing technology and settlement, the number of villages, towns, and cities grew and the number of people in these agglomerations increased. In the decade of 1900 to 1910, Ohio's urban centers accounted for one-half of the population. By 1970 over three-fourths of the people lived in such places. The first major city in Ohio was Cincinnati on the Ohio River. For quite some time it was justly called the "Queen City of the West." Today its population gives it third ranking in the state for metropolitan areas. Cleveland surpassed Cincinnati in population near the turn of the century and its metropolitan area is first in population. Columbus ranked second in the 1970 census. Other metropolitan population centers in decreasing order of population numbers are: Dayton, Toledo, Akron, Youngstown-Warren, Canton, Lorain-Elyria, Huntington-Ashland, Hamilton-Middletown, Wheeling, W. Va.-Ohio, Lima, Steubenville-Wierton, Springfield, and Mansfield.

Ohio's population density went over the 200-per-square-mile figure in the decade from 1950 to 1960; in 1970 it was slightly over 260 per square mile. From the population map one can readily see that this is not evenly distributed. In fact, large areas of the southeast have a very low population density while the urban centers of northeastern, central and southwestern Ohio have quite high population densities.

Ohio's increasing population and the rising standard of living have made it a high supply-high demand society. Such a society produces a tremendous quantity of wastes. In the past its people freely spewed waste materials into the air, spilled them into the waters, and dumped them onto the ground. When a low supply-low demand society predominated, it could do this with a certain degree of impunity. The environment did accept these materials; bacteria and other natural methods recycled them without much damage to the environment. However, as supply of resources and demand for resources increased, the environment became more and more degraded until in some areas we crossed the critical threshold of the environment's ability to process this material. In some of our urban areas we are literally living in our own waste materials.

With the federal Water Quality Act of 1965 and the numerous changes to that basic act, Ohio has moved ahead in applying technology to cleaning up its streams. The Ohio Water Development Authority has aided many communities and industries through loans and technical advice. Most streams are being improved at the cost of millions of dollars. The regional water plans being developed by the state will give long range guidelines which should help the situation.

The increasing number of automobiles, factories, incinerators, and power plants have degraded the air in some localities so badly that air pollution has been named the direct cause of numerous deaths and illnesses. Air pollution becomes especially dangerous when a high pressure system stagnates over an area for a period of time. In this situation, the subsidence inversion frequently combines with the radiational inversion to prevent upward movement of air, thus creating air pollution by preventing vertical distribution of the pollutants. As late as January, 1973, air pollution in some parts of Ohio became so bad that the Ohio Environmental Protection Agency declared an emergency in Steubenville and Cleveland, shutting down industry and restricting automobile travel to protect the health of these Ohioans. At the same time the pollutant levels were nearly as high at Cincinnati and Portsmouth and an alert was almost declared. The federal Air Quality Act of 1967 and its amendments have encouraged the state to set pollution standards which are enforced by the Ohio EPA. Gradually the air quality will be improved, but the quality of air that was in existence at the time of Ohio's settlement will probably never be reached again.

Technological improvements and an organization for watching danger signals may well prevent the great damages to health and property that were experienced in our past history. When an emergency is declared for an area, manufacturing companies must reduce emissions into the air and people will be requested to drive less, resulting in fewer pollutants getting into the air. This does not mean that we will not have deaths and illness from air pollution, but it does mean that we are working on the problem.

The amount of solid waste from our high supply-high demand society has created a major problem of disposal. Some of this material is incinerated, but this frequently creates air pollution. Some of the material is dumped onto the ground and becomes an unsightly source of foul odors and disease. Some is put into landfills but these require large areas of land and a proper choice of sites. Many such sites have become rat infested or have water leaching through them into the ground water so that the ground water becomes polluted. Stream pollution from landfill dumps is not uncommon.

Many solutions have been proposed for our solid waste dilemma. Many people are suggesting that recycling solid wastes is the answer. The best example of this is to be found at Franklin, Ohio, where a municipal recycling plant sorts out the fibrous materials, metals, and glass for resale and processes other materials in the sewage treatment plant from which the residues are incinerated. The plant has become world-renowned. However, the economics of the process are such that only medium to large cities can afford to use it. Paper drives, bottle and metal collections have helped, but they are usually based on free adolescent labor and are effective only so long as the concerned citizens remain concerned. Under our present economy most of these drives would not be economically feasible without free labor. Some critics even question the viability of recycling because some of the paper and metals are being stockpiled and are not being recycled. Here, then, is an area of pollution where more research and laws are needed to help man and his environment.

Increasing population, increasing manufacturing, increasing urbanization, increasing levels of living, and increasing population densities have created real environmental problems. Ohioans are accepting the challenge and are beginning to realize that their continued existence is threatened. State and local governments are making progress in trying to control man's use and abuse of the earth. More and more we realize that man must learn to live in harmony with his physical environment and not just conquer it. Are there places in Ohio where one can commune with nature? Are there Waldens in existence? Are there places that are aesthetically pleasing and beautiful? Yes, there are and we must do everything possible to protect them for future generations. Quality of the environment and quality of life must become our theme for the future.

Dr. John Thompson
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President of the Ohio Conservation and Outdoor Education Association

Population of Ohio

Year	Population (000)	Decade Change (000)	Per Cent Change	Per Cent Urban	Density per sq. mi.
1800	45				
1810	231	185	409	1.1	6.8
1820	581	350	152	1.7	14.2
1830	938	357	61	3.9	22.9
1840	1,519	581	62	5.5	37.1
1850	1,980	461	30	12.2	48.3
1860	2,340	360	18	17.1	57.1
1870	2,665	325	14	25.6	65.1
1880	3,198	533	20	32.2	78.1
1890	3,672	474	15	41.1	89.6
1900	4,178	486	13	48.1	101.5
1910	4,767	609	15	55.9	116.4
1920	5,759	992	21	63.8	140.6
1930	6,647	888	15	67.8	162.2
1940	6,908	261	4	66.8	168.6
1950	7,947	1,039	15	70.2	194.0
1960	9,706	1,759	22	73.4	236.9
1970	10,652	946	10	75.3	263.2

Source: U.S. Department of the Census, U.S. Census of Population, 1970. *Number of Inhabitants.* Ohio: Final Report PC(1)-A37

PLANNING THE LANDSCAPE FOR TOMORROW

Planning the future for Ohio's 41,000 square miles of landscape must take into account all of the assets of the state in their natural condition and how they are altered from their natural state by man's activities. The goal of this work is to permit valid trade-off decisions to be made about how our natural assets are used—by 11 million Ohioans now, and by future generations.

Planning requires that we know what we are talking about now (that we have a workable data base and an historical perspective of how it developed); that we know where we want to be sometime in the future (we have some citizenry goals); and that we have a reasonable, acceptable plan for getting there (trade-offs between conflicting uses of land and resources are identified, evaluated, and decided upon). Planning for tomorrow and necessary citizen participation is easy to talk and write about, but very difficult to put into practice.

For example, one of the most critical problems in the state is the paucity of detailed information on the nature, location, and extent of natural resources available.

A resource inventory is the first step in planning Ohio's landscape for tomorrow. Intensifying the state's geologic mapping program of extractable minerals and marking potential zones of geologic hazard, as well as the common forms of geologic mapping discussed elsewhere in this book, will make this possible.

The methods used to obtain information and act on it (monitoring) are crucial to this process. Fortunately, the National Aeronautics and Space Administration (NASA) is conducting an Earth Resources Technology Satellite experiment (ERTS) in Ohio that offers potential to make an effective monitoring job possible. The satellite takes pictures of the Ohio landscape (about 100 square miles per shot) once every 18 days at four different frequencies in the electromagnetic spectrum. This information has proven useful in demonstrating how mineral resources are being mined and pointing out changing landscape conditions. Future demonstration projects and the ERTS II program scheduled for 1976 are expected to produce much of the information needed for effective planning.

Detailed physical and chemical characterization of water resources still is necessary for water utilization management. In addition, a soil mapping and inventory program must include specific data on biogeochemical cycles, erosion characteristics, and plant growth capabilities. More detailed inventories of Ohio's biotic communities that include specific population and health numbers on plants and animals are in order.

Another requirement for decision-making about land use is an inventory of unique areas in the state. Completion and updating of data on historical, archaeological, and natural area sites must take place. Establishment of criteria for ranking the value of these sites will be an important part of this task.

Potential storage sites for waste materials and wastes that can be recycled must be identified and specified for this use.

Finally, the citizen population distribution—location, concentration, rates of growth—must be known in order to determine future demand levels for natural resources. The conflicting demands that people make upon a land-use system for the items in life that we have taken for granted in the past are all too obvious. The key task in planning tomorrow's landscape is to help citizens and land-use decision-makers make reasonable and responsible judgments about these conflicts.

For example, let's suppose that major improvements are suggested for a highway that crosses a county seat and a number of cities and villages, and involves several relocations of the road. Officials from the county, adjoining counties, affected cities and villages, and state agencies are included in the planning and execution.

A few of the dozens of their considerations are:

- ☐ How many people will have to be relocated, and where will they go?
- ☐ How will the project affect the location of new schools and the operation of existing schools?
- ☐ How will the project change the quality and accessibility of such services as law enforcement, fire-fighting, hospitals?
- ☐ What differences will there be in shopping, banking, and entertainment patterns?
- ☐ Will natural drainage along the right-of-way be upset?
- ☐ What effect will there be on the area's ecology: noise levels, wildlife, physical appearances, air and water pollution?
- ☐ Will new sewage facilities have to be built, perhaps in areas of high costs?
- ☐ Will the project attract new industry, and increase employment opportunities and population?

This is what planning the landscape for tomorrow is all about.

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Ohio Department of Development

Cuyahoga-Grand River Watershed Region

BACKGROUND INFORMATION

Biophysical Environment:
In addition to the Cuyahoga and Grand Rivers, numerous other streams flow through this region. The Mahoning River and a small part of the Tuscarawas, a tributary of the Muskingum, are parts of the Ohio River system. All the others lie on the north side of a great divide determining which rivers drain into the Ohio and which go into Lake Erie. Comparing watershed patterns of flow, we note that the Cuyahoga, meandering down from the wooded hills that blanket much of the upper reaches of the watershed, flows southwest to Akron. Then it abruptly turns northwest and continues its course to Lake Erie. The Mahoning rises in northwest Columbiana County, flows northeast for some distance, then bends sharply to the southeast. The Grand River has its headwaters in Geauga and Trumbull Counties. The river wanders north to a point ten miles south of Lake Erie and then it turns abruptly west, finally veering northwest to enter the lake at Fairport.

Stream configurations tell the geologic story. The region is underlain by rock strata ranging in age from the Devonian shales on the north and west margins of the area (see geologic map) deposited 350 million years ago to the Pennsylvanian Sharon conglomerate of 250 million years. Long periods of erosion had taken place prior to the Ice Age which resulted in pre-glacial stream valleys. Then came the period of glaciation when the walls of ice impounded the streams causing stream reversals and abrupt changes in direction of flow.

The region thus presents a varied landscape of lake plain and glaciated Allegheny Plateau with rivers running in all directions. The glacier left other features also: thick accumulations of drift in the lowlands, morainic hills, knobs, marshes and lakes, eskers and kames. The latter two are deposits of water-laid sand and gravel resulting from the heavy flow of meltwater from within the glacier or its front. Old post-glacial lake beaches may be seen on the landscape above the valleys. These represent stages in the ice retreat which formed a series of lakes, forerunners of Lake Erie.

As indicated by E. Lucy Braun (1950) and others, the native forests of the Western Reserve are a part of the extensive deciduous forest biome of Eastern North America. (See vegetation map.) Studies have shown that vegetation in northeastern Ohio was dominated by beech and sugar maple. Many other species such as oaks, hickories, ash, elm, walnut, cherry and chestnut were intermixed with the beech and maple. Except for the chestnut the same species are found in the area today. In Geauga County the making of maple syrup and sugar indicates that maples are still abundant in places.

Flowering plants found in the ground layer of the deciduous forest are typical flora of the acid soils on the Allegheny; trout lilies, Dutchmen's breeches, spring beauty and toothwort represent the ephemerals (short-lived species). Other species, bloodroot, Jack-in-the-pulpit, wild ginger, blue cohash, hepaticas, May apple and the trilliums occur in a pattern maintained throughout eastern and southeastern Ohio.

Sections bordering Lake Erie and other poorly drained parts of the region originally were covered with lowland swamp forest. Along the gorges and ravines the vegetation type was and still is typically northern. Eastern hemlock dominates although it is mixed with white ash, tulip tree, white oak, tupelo and others. White pine was found extensively in many areas of Ashtabula and Geauga Counties and attained dominance with hemlock, especially on moist, slightly exposed sites. On many sites hemlock and beech-maple represent two antagonistic climax types (Edward L. P. Hauser, *The Original Vegetation of the Western Reserve*, 1966, reprint from *The Explorer.*) Professor Hauser states that relict hemlock stands can be found along the river at Virginia Kendall Park and Brecksville Reservation.

Aquatic plant associations in Erie County, between the sand-bar sections along Lake Erie's shore and the mainland, where 4000 acres of pure marsh exist, have been continuous over a very long period of time. These contain layers of plant life showing striking habitat adaptations. Post-glacial bogs are common in the eastern counties of the region with tamarack in association with numerous northern bog species. Wet prairies occurred frequently in Huron and Erie Counties, and survey records indicate a fragment of prairie existed in Lorain County, representing the most eastern extension of this vegetation type in Ohio. Today no remnants of the original prairie in the Western Reserve exist. It has been used for agricultural purposes for over a century.

Socio-cultural Development:

"For over 2,500 years, the Cuyahoga valley region has provided transportation and living space for countless men. An ancient tribe of mound builders, the Fort Builders, lived here from 600 B.C. to 800 A.D., leaving remains of their mounds and rocks bearing their inscriptions. One such stone with its inscriptions now forms part of the west wall of the Presbyterian church in Independence, Ohio. Some artifacts from that ancient time have origins in the Dakotas and the Lake Superior region, which suggests that even then the river was part of an important transportation network, especially along the 40 miles from present-day Akron to its mouth at Lake Erie. The valley's importance in transportation was linked to its closeness to the Ohio-Mississippi

River system to which there was an easy eight mile portage.

"The Indian tribes, Erie, Mohawk, and others, that came years after the mound builders, named the river Cuyahoga, or 'Crooked River' as it is usually translated. The Five Nations tribes eventually defeated the Erie tribe and occupied the area. Throughout most of the Indian history, the Cuyahoga region was kept neutral and 'sacred ground' because of its value for transportation and access to flint quarries in the region. Before the coming of the white man, as many as 10,000 Indians at a time lived in the lower 40 miles of the river" (Corps of Engineers, Buffalo District, *Cuyahoga River Resoration Study* September, 1971).

Following the successful campaign of Anthony Wayne and the Treaty of Greenville (1795), an extensive post-Revolutionary migration from New England began. It had already been responsible for the founding of Marietta and towns along the Ohio River. The Western Reserve was a 120-mile strip of land west of Pennsylvania and south of Lake Erie which Connecticut had retained as a part of her claim in 1786. (. . . "Connecticut, for good reason, claimed ownership of this Ohio land, and her title was sustained amid controversy by the newly developed authority of the colonies organized into the United States of America. The details of this story are involved in devious legal technicalities" (Harlan Hatcher, *The Western Reserve*).

The Western Reserve was closed to immigrants until the Indians had been definitely subdued. Once it was open it became the natural goal for the overflow from New England. The lands of the Ohio Company in the south were accessible only by a long and difficult journey across the Appalachians and down the Ohio, whereas the old Iroquois Trail in central New York and in northwestern Pennsylvania, proceeding from Niagara on the Lake Trail, led directly to the Western Reserve.

Part of the land in the Reserve was granted to inhabitants of Connecticut coast-towns who had suffered extensive losses from British depredations during the Revolution. This "Half-million Acres of Land lying South of Lake Erie" became known as "Sufferers' Lands," or more commonly Firelands. Actual settlement was not undertaken before 1808.

The Connecticut General Assembly agreed to sell the remaining part of the Reserve to a group known as the Connecticut Land Company. Moses Cleaveland, a representative of this company, was assigned the responsibility for surveying the land. Shrewd and courageous, Cleaveland gathered together a party of 52 well chosen cohorts: additional surveyors, a physician, a commissary and other employees. This party, which included two wives, reached the northwest cornerstone of Pennsylvania, and proceeded to the Conneaut River where they celebrated the Fourth of July (1796) as well as their first steps into the Western Reserve. The next day they began their surveying in earnest. While some of the men traced the Pennsylvania line south through rocks, ridges and swamps, Cleaveland himself, with a portion of the party, went west in an open boat on Lake Erie, landing at the mouth of the Cuyahoga on July 22, 1796. Early explorers had recognized the value of this excellent harbor. Cleaveland and his men enthusiastically noted the advantages for settlement, which included the precipitous shale bluffs that overhung the river and protected the area from attack. These men built three cabins as the nucleus for the permanent settlement and paced out what remains to this day as Cleveland's Public Square. Cleaveland permitted the use of his own name for the new site. The spelling changed later (1832 or 1833) because one of the type letters "a" in the heading of the Cleveland Herald could not be used, and the typesetter simply omitted it (Beverly W. Bond, Jr., *The Foundations of Ohio*. Vol. 1., 1941).

Cleaveland faced severe obstacles in his work, for after the first burst of enthusiasm his party had become discouraged. Provisions were skimpy and the New England rum was often lacking. To encourage his men Cleaveland agreed to give each a personal stake on the land in addition to his pay. But the bait could not hold the men during the winter, and they returned to their eastern homes. The three months of surveying had been profitable, but a large part of the Western Reserve had not been touched. The two permanent settlements were left in the care of the men who had brought their wives. There was enough to start the great migration. More surveying was to come later.

Like the Ohio Company in the upper Ohio Valley, the Connecticut Land Company by its liberal policies ensured the rapid development of the Western Reserve. Of great importance was the interest aroused by the successful settlement in the southern sections. Sales promotion by agents of the Connecticut Land Company was made easier by this success.

Conneaut, Painesville and Cleveland were established within a year or so of each other, with Cleveland as the only lake site. For more than a generation Cleveland lagged behind the other two. Interior settlements of the Reserve and just south of it grew more rapidly than those to the north. Although Warren, Youngstown, Akron and Kent were established later, they lost no time in becoming important local centers.

For the first decade of settlement in the Reserve the story is not a particularly joyous one. The pattern was different from that along the Miami, the Scioto and the Muskingum where people banded together to form sizable villages, to sustain one another, trade with southern neighbors, and maintain an acceptable quality of life. In the northeastern part of Ohio the immigrants — frugal, hardy, industrious, often well educated, independent in spirit—settled a multitude of very small villages with two or three families constituting a unit. Journals, which were commonly kept by clergymen and others, relate the stories of great hardship, lack of supplies, bad roads and general discouragement. In 1811 Cleveland had only 16 dwellings, two taverns, two stores and one school. Trade was limited to salt, or sometimes a little flour, pork and whisky. The Cuyahoga Flats were extensive and fertile, but the river, at this time clogged with sand at its mouth, gave off a putrid smell from decomposing vegetable matter. It was obvious that the harbor needed to be deepened, roads improved, and canals built to connect the region with more flourishing southern parts of Ohio.

Self-sufficing agriculture was maintained, but one writer indicates that the grain produced was frequently converted into whisky. Sheep and cattle were scarce, hogs more abundant. Hatcher gives this statement in painting the dismal picture of 1820: "the inescapable fact seems to be that conditions were wretched during the first quarter of a century, and that no improvement was likely to come without a transportation system and a supply of cash." (Hatcher, *op. cit.*)

The lives of many of the settlers, including some from the original Connecticut Land Company, were further complicated with indebtedness. The pioneers were unable to meet the contracted payments for their land; this in turn meant bankruptcy for the leaders of the land company. History relates that one man, James Hillhouse, a young Connecticut lawyer and Congressman, deserves the credit for improving this situation. He accepted the responsibility to straighten out the School Fund for the State of Connecticut which was contingent upon the payment for lands in the Reserve. This he succeeded in doing during the remaining years of his life by patiently untangling the affairs of the debtors, negotiating sales, payments and settlements. "He who could have had a life of ease and wealth in New Haven chose instead the hardships of administering the finances of the frontier" (Hatcher, *op. cit.*). Hillhouse lived to see the construction of the canal across the Reserve which linked it with the markets of the world, and the children of the pioneers begin their march toward propserity.

Canals came to both northeastern and southwestern Ohio at about the same time, between 1825 and 1847. The Ohio and Erie Canal threw open the Erie ports as markets for farm produce from the interior. Two feeder canals were constructed from the east, the northern one connecting with the Ohio and Erie Canal in the Akron area, the southern one, called the Sandy and Beaver Canal, joining it in the Canton area. Even though they were much needed at the time, the latter was never used in its entirety and the former was used for a short time only. It was the rise of commerce in upper lakes minerals and lake shore trade which marked the end of the miserable pioneer economy, and a dramatic growth in population was witness to the change. (Note population map).

The Western Reserve at the outset was a part of New England transplanted beyond the Alleghenies. Many towns and villages have retained a dignified but homelike New England quality with public squares surrounded by white New England-style houses, spires of fine old churches and white fences. The names of towns south of Lake Erie bear New England names: Dorset, Andover, Norwalk, New Haven, Greenwich and many others.

But the Western Reserve is not a miniature New England. "It is a region of arresting contrasts of which Akron and Tallmadge are appropriate symbols. Descendents of the Puritan Mathers share the Reserve with the Slovenian Lauches, only one generation removed from the mountains of Yugoslavia. The campus of Western Reserve University, with its strong New England tradition, has for its neighbor the Cleveland Cultural Gardens wherein fifteen foreign nationality groups pay respect to their unique cultures with formal gardens and statues honoring Goethe and Schiller, Virgil, Liszt, Shakespeare. The extensive and rich greenhouses and truck farms of the Hungarians, Slavs, Czechs, and Italians on the west slopes of the Cuyahoga River, almost in the heart of the city of Cleveland, face toward the booming industrial plants in the Flats and the wealthy suburb of Shaker Heights on the east. The New England campus of Lake Erie College and the wooded public green of Painesville look down the slope of Grand River to crowded Fairport Harbor where the big ore ships from Duluth put in to be serviced by the Finns who settled here a generation or two ago. Lorain, with its heavy concentration of Poles, Slovenes, Hungarians, and Italians around the giant works of the American Ship Building plant and U. S. Steel's National Tube Company plant, is only fifteen miles away from the spacious square which serves as the central campus for Oberlin College, steeped in an intellectual tradition redolent of New England." (Hatcher, *op. cit.*)

One of the earliest uses of natural mineral resources was the making of skillets, kettles and stove parts from iron ore found in the Pennsylvania strata of eastern Ohio. The Vanport ore was found in a narrow vein in association with the limestone needed as a flux in the furnaces as well as sandstone to build and line the furnace stacks. Coal, too, was available, but early furnace masters preferred charcoal which was made from the hundreds of square miles of virgin timber available in the area. The two fuels were used at the same time in different furnaces for many years. Most pioneer coal was mined in the Mahoning Valley and the Tuscarawas Valley between Akron and Massillon. The coal was known to be available long before the canal came but shipment over the existing roads prohibited transport except to the largest towns. When rich iron ores were discovered in Upper Michigan and later in Minnesota, and the lake ports were developed for handling the material, the use of Ohio ore was discontinued. For a number of years Cleveland monopolized the ore imports, but as railroads were constructed connecting other Erie ports with the furnaces in the Mahoning Valley, the iron and coal shipments were shared by them.

Salt deposits were common and salt was a prime pioneer necessity. Later, chemical industries were to utilize this valuable mineral, which is found a half mile or more below the surface. Today the greatest salt producing districts for both brine and rock salt occur in a 1,000-square mile area of eastern Ohio.

Both northeastern and southwestern Ohio had pioneer quarrying industries. Both sections used local stone to build homes for affluent citizens; both used it for locks and dams which went with the construction of canals. Bridges, public buildings, curbs and sidewalks utilized stone in both regions. But the variety in color, texture and composition of the sandstone, and the utility some of it had for grindstones and millstones helped give northeastern Ohio a more important quarrying industry. The Berea area has long been the most important producer of sandstone in the state.

Sand and gravel obtained from glacial deposits were later of great importance in road construction and remain so to the present.

Limestone was quarried extensively in Erie County on the Marblehead peninsula and at Kelley's Island. Operation has ceased on Kelley's Island but some limestone continues to be mined in the region for rip-rap, concrete, and road building.

The use of clay and shale for the manufacture of common clay products, cement, refractories and vitrified products has been extensive in Cuyahoga and Mahoning counties as well as others in the Muskingum Region lying just south of them. Although petroleum was extracted in Trumbull County in 1859, northeastern Ohio was not a part of the most important Ohio oil fields.

During the years of population increase, the first major change in the rural pattern of farming was the increase in dairying. The New England precedent, the rolling topography which was suited to hay and pasture, and the growing market promoted this first important specialty in northeastern Ohio.

The growth in population as a result of urbanization after the advent of the canals and railroads was responsible for further changes. Nothing like this urbanization took place elsewhere in Ohio. The lakeside markets have fostered an intensive agriculture of grapes, berries and vegetables. Most of the vegetables grown under glass are localized around Ashtabula but few districts are lacking in some representation of this pursuit.

The rise of steel, ore, clay, and chemical industries in northeastern Ohio was responsible for a tremendous amount of commerce by lake, rail and highway. The only competitor in tonnage is the coal exporter, Toledo. Commerce means urbanization, and the growth of cities and towns in this region was equaled by no other region, prior to the Depression. Each of the cities has its own story to tell.

When Moses Cleaveland and his small party of men first landed on the forested slopes along the Cuyahoga little did they realize that the tiny village they established would one day be the largest city in Ohio, the eighth largest in the nation. The city stretches 50 miles along the lakeshore and 20 miles inland. Seventy suburbs greatly extend the area and the population concentration. The early New England pattern has been overlaid with a cosmopolitan industrialism. The first blast furnace in the city opened in 1852 soon after ore was discovered in Michigan. This was the beginning of Cleveland's rise as a great primary steelmaker which led to the extensive manufacture of transportation equipment, machinery, and fabricated metals. To John D. Rockefeller goes credit for giving an early impetus to bringing the ore to Cleveland, as well as the refinery which was to be the start of Standard Oil and of the greatest fortune in American history. Charles Brush, inventor of the carbon arc light, gave the city electric street lights in 1879. Cleveland became a transportation crossroads served by five railroads, 12 airlines, and 33 steamship lines.

Like Cincinnati, which Cleveland exceeded in population by 1900, Cleveland produced many wealthy families who shared their good fortune with the city. The Terminal Tower and a downtown mall were created in the 1920's. Eastward from the downtown section stretches a chain of those gifts: a botanical conservatory, an aquarium, a planetarium, beautiful museums of art, natural history and health, concert halls, fountains, flower beds and the Case Western Reserve campus. Farther out the city is encircled with a famed "Emerald Necklace" of public parks, golf courses, group camping areas and natural environment habitats little influenced by man. A high level bridge going into the city from the south creates a stark contrast with flaming blast furnaces and steel mills, smoky murk, an oily looking river, and unending traffic.

Cleveland's representatives of many nationalities and Blacks from the South have largely furnished the huge labor force necessary for its industrial growth. About one-third of the city's people are Blacks; Cleveland achieved another first in 1967 when it became the first large city to elect a Negro mayor.

Carl F. Wittke, of Western Reserve University, in an address entitled *These Ohioans*, delivered at the opening of the exhibition commemorating the 150th anniversary of the statehood of Ohio, tells the history of the Irish in Ohio and the Cleveland area. "These people from the Emerald Isle began coming to America in large numbers during the famine years of the 1840's. Thousands, with pick and shovel, dug canals, built railroads, and worked in mines. In Cleveland, Irish laborers settled on Whisky Island and in 'the Flats,' making it a strong Roman Catholic center. From these poor, untutored, unskilled and often intemperate Irish laborers, the present large and important Irish element in Ohio is largely descended. Paddy became a boss, a businessman, lawyer, priest or politician. Bridget hung up her kitchen apron to become a seamstress, a saleslady, a secretary or a schoolteacher."

Like the Irish, the Germans, Poles, Italians and Serbs have made contributions and climbed to posts of importance in all walks of life.

A city of almost 300,000 inhabitants, Akron has been recognized as the rubber capital of the world. For years the city failed to expand greatly due, in part at least, to its inland situation. During the 19th Century, English, Welsh, Irish, and Pennsylvania Dutch came into the district, and from the efforts of these enterprising people Akron became a great industrial city. The manufacture of steel, clay products and cereals was eclipsed after 1880 by the growing rubber industry. Goodrich chose Akron because it was a railroad town, could supply ample water and was reasonably close to raw material. The Goodrich company and other rubber manufacturers became greatly diversified in their products. Research-minded, they have gained recognition for their advances. When synthetic rubber was introduced, there was no industrial decline or great change. Culturally, Akron, like other Ohio cities, has outstanding museums, historical sites and metropolitan parks preserving natural and man-made environments.

The city of Youngstown was named for John Young, one of its first settlers. The discovery of iron ore in the rock strata initiated the city's growth as a world center for steel manufacturing. A blast furnace was put into operation as early as 1808 on Yellow Creek, the infant of an iron industry which would extend through the entire Mahoning Valley. Local bituminous coal (Briar Hill) was the fuel for the first decades, but after the Civil War coking coal from Connellsville, Pennsylvania, was brought in. Republic Steel was responsible for modernizing methods and mills in 1899 with emphasis on primary products. Youngstown Sheet and Tube and Carnegie-Illinois, together with Republic Steel, produce three-fourths of the pig iron and steel processed in the Mahoning and Shenango River valleys. Youngstown is famous for its Mill Creek Park, a scenic oasis in a highly industrialized valley.

A few miles from Youngstown is the city of Warren, founded in 1799 and the proclaimed seat of the Western Reserve. Because of its location on the Mahoning River and its resources of iron ore, charcoal and local limestone, it early became an iron town as well as a political and business center of the Western Reserve. In 1912 the Trumbull Steel Company introduced the modern industrial period for Warren and steel again became the important industry.

Nearby Niles was the site of the first tin plate mill in the United States. Hundreds of workers came from the plate mills at Swansea, Wales, to provide the skilled labor for this mill. Many of their descendants live in the area today.

The harbor cities of Conneaut and Ashtabula (populations 14,552 and 24,313 respectively) are important iron ore and coal shipping ports. Conneaut is famous as the site of the Fourth of July celebration in 1796 when Moses Cleaveland and his party reached the Western Reserve.

Lorain is the largest city in the western part of the Western Reserve, with more than 81,000 people. Situated on Lake Erie, it has been an important port and shipbuilding center since the early 1800's. It was missed by the canal and the first railroads but achieved industrial growth because of its proximity to Cleveland. A devastating tornado hit it in 1924, resulting in a property loss of $25 million, but the city was successfully rebuilt. The giant works of the American Shipbuilding plant and U. S. Steel's National Tube have attracted a heavy concentration of Poles, Slovenes, Hungarians and Italians.

Sandusky is located in a county which was part of the Firelands Tract granted by the state of Connecticut to citizens who had lost property at the hands of the British. It was also one of the last strongholds of the Ottawa Indians. It was settled in 1817 and became a prosperous shipping port because of its protected and land-locked bay. Trade declined when Toledo and Cleveland became terminal points for the canal systems. Today it houses several large corporations and has heavy traffic in bituminous coal. Its location near the islands of western Lake Erie and its rural setting near the low lakeside cliffs have promoted recreational uses for more than a century. Resthaven, a wildlife refuge established on a wet marl prairie by the Ohio Division of Wildlife, is near Sandusky.

Kelley's Island lies about ten miles from the mainland, north of Sandusky. In the early days of the Western Reserve it remained uninhabited, but in 1833 the land was acquired and its red cedar forest cleared. The island is underlain by Columbus limestone which was quarried extensively after 1850 until the 1930's. In 1907 the Kelley Island Lime and Transport Company advertised their company as the largest of its kind in the world. It imported workers from all parts of Europe—Italians, Slavs, Greeks, Hungarians, Poles and Germans. Some lived on the island, others in the vicinity of Marblehead. With this operation no longer functioning and the grape industry and fruit orchard business not as flourishing as they were earlier, the economy of the island is sagging. A state park, prehistoric Indian inscriptions and deep grooves cut by the last glacier make it still a choice bit of the Western Reserve. Without a doubt the most spectacular geologic features in Ohio are the Kelley's Island glacial grooves, giving an impressive display of glacial power. As deep as a man is tall, they were gouged out of the relatively soft limestone rock by hard igneous and metamorphic boulders carried in the ice from Canada.

Elyria, with a population of over 50,000, was always a prosperous city based on local industry. At one time it specialized in auto parts, bicycles and primary steel. Today its metal products are highly diversified.

Oberlin, home of Oberlin College, has been a prototype of New England college towns. The college was established in 1834, the first coeducational college in the United States and one of the first to admit Negroes. Charles Martin Hall, later a top official of the Aluminum Corporation of America, perfected the revolutionary electrolytic process for aluminum here, and on his death endowed the college with millions of dollars. Oberlin was the first town in the nation to enact a fair housing ordinance.

Man's Impact on the Environment.

Land Use and Resource Management:

A resume of land use and resource management in this region establishes the following situations:

The Western Reserve has evolved from scattered communities and self-sufficient agriculture to a highly urbanized, heavily populated area, except in the upper reaches of the component watersheds. On the eastern portion approximately a fourth of the land (or less) is forested, partially in state or metropolitan park reservations; a third is in pasture or cropland, with a higher percentage in crops within the western counties. About ten percent is unoccupied land, held for real estate sale or abandoned as unprofitable farmland. The lake front is largely urban or industrialized from Lorain to Conneaut. River valleys are virtually winding corridors forming a megalopolis from Cleveland up the Cuyahoga River to Akron and Cuyahoga Falls, from Youngstown up the Mahoning River to Warren and thence west to Akron with an extension to Pittsburgh. Rubber, steel, machinery, transportation equipment, fabricated metals, electrical equipment, chemicals and oil refinery constitute the major industries in the eastern section; vigorous greenhouses, truck gardening and nurseries are important agricultural pursuits concentrated along the lake and urban developments.

Resource utilization and management involve all the area's industrial pursuits—coal mining and its use in iron furnaces, extensive lake port shipping, exporting coal and importing iron ore, clay and shale processing for vitreous and other clay products, and extraction of sand and gravel for construction and road material.

Population has climbed steadily with estimates for the year 2000 to be 2,275,000 for the Cuyahoga and Chagrin Valleys alone. The attendant environmental problems of water use and quality, sewage and solid waste disposal, energy and recreation demands have soared to unbelievable magnitudes.

Water quality is dependent upon industries, cities, and suburban areas meeting water quality standards. Two studies of the Three Rivers Area (Cuyahoga, Chagrin and Rocky River Watersheds) by the Corps of Engineers, Buffalo District, were made prior to 1973. One was the *Cuyahoga River Restoration Study;* the other, *Alternatives for Managing Wastewater in the Cleveland-Akron Metropolitan and Three Rivers Watershed Areas.* The Cuyahoga study deals with water quality, recreation, stream supply, fish and wildlife, flood control, erosion and sedimentation, aesthetics and navigation. The wastewater management plan deals with the treatment of municipal and industrial wastewaters and urban stormwater runoff entering the streams. The latter effort has provided a planning service to the State of Ohio from which the most acceptable alternatives will be selected.

The Corps of Engineers describes the following types of treatment for an understanding of wastewater processing:

Primary treatment — removing about 40 percent of the pollutants from wastewater by letting them settle out.

Secondary treatment — removing additional pollutants through a bacterial process, by trickling filters, activated sludge or aerated lagoons. This is the highest level of treatment currently provided in the Three Rivers Area. The effluent is 85 percent pollution-free.

Advanced treatment — removing essentially all pollutants from wastewater, concentrating on nutrients which have not been removed by primary and/or secondary treatment. Removal of pollutants by this process is 99% efficient. This is the treatment required to meet our environmental goals.

The technologies of advanced treatment include:

Physical-chemical—pollutants are removed by chemical action and gravity settling.

Biological — bacteria digest the organic pollutants in wastewater and chemical action, coupled with settling, completes the process.

Land Treatment — irrigation techniques are used, after secondary treatment, to apply effluent to agricultural land, where the "living filter" of the soil zone purifies the water as it percolates downward. The Corps study includes twelve alternative plans for the Three Rivers Area, some singly and some in combination, using the wastewater treatment techniques above. The publication, *The Quest for Quality*, delineating these and including excellent diagrams and charts, is available upon request from the Corps of Engineers, 1776 Niagara Street, Buffalo, New York 14207 or Chief, Water Planning, Ohio Department of Natural Resources, Fountain Square, Columbus, Ohio 43224.

This and other water problems treated in the *Cuyahoga River Restoration Study* are relevant to the entire region. Joint water supply planning on a watershed basis must take into account geologic structures; the limitations on the infiltration of precipitation caused by urban, suburban and industrial land use; the history of flooding now increased by excessive run-off of rainfall in urban areas; steadily increasing population; and industrial consumption.

Flood plain zoning has been a state-wide recommendation. Not only rivers, which are not as critically rampageous in this region as in others in Ohio, but lakefront policies require careful consideration. Recent flooding along the lake shore, particularly at Sandusky and Toledo in 1972 and early 1973, was predicted in 1904 by one of Ohio's leading scientists. Addressing the Ohio Academy of Science as its president in Cleveland, Edwin Lincoln Moseley traced in detail the two forces which are continuing to alter the south shoreline: one, an upward tilting of the eastern part of Lake Erie, thus raising its outlet level; and two, erosion by violent storms during periods of heavy rainfall.

Dr. Jane L. Forsyth, geologist at Bowling Green State University, writes the following, which is based on accumulated studies of Lake Erie in the years since Dr. Moseley's time:

"This last year, 1972, is a year that anyone living along the shores of Lake Erie will never forget. Never has the lake been as high as it was last fall. Worse, when the water level is this high, waves do not break harmlessly on the shore; they attack the beach homes themselves.

"Many have asked why the lake is now so high. The answer is the same as for any other lake — there has been so much precipitation, during the last few years, in the greater watershed feeding the lake, that the lake is fuller than usual. The level of the lake is basically determined by the level of Niagara Falls. However, when there has been a period of excessive precipitation, not in the Lake Erie area so much as in the drainage basins of streams feeding the upper lakes, then all this water flows down from those streams and lakes into Lake Erie, filling it fuller than usual. As the amount of precipitation in this drainage area decreases, the lake level will eventually lower. However, the upper lakes are presently so full that Lake Erie should be as high next year as it was this year, if not higher! Even if the Corps of Engineers close off the main flow from Lake Superior, as the President has requested, Lake Erie will be fairly high, though not as high as it would be were this not done.

"This high water level is not permanent. Records kept through the last 110 years by the U.S. Lake Survey Center in Detroit show that the lake level has followed a very rough 21-year cycle of high and low water. The lake was very low during 1964-65, and in 1952 was high but a little lower than it is now. Based on this past pattern, it seems likely that the lake level will begin to lower in another two or three years, and will be at the low part of this cycle by about 1985. These cycles are not exact, nor are the heights of the lake the same during the high part of each cycle. In addition, there are many small-scale variations superimposed on this overall 21-year cycle.

"The November, 1972, storm did excessive damage for two reasons: the lake was as high as it has ever been, and the storm came from the northeast. A northeast storm can do more damage in the western end of the basin than any other because the winds blow the whole length of the lake (a long fetch) and thus attain tremendous strength. The lake water itself is blown westward, raising the level of the water at the west end of the lake as much as five feet. This bulge of water (seiche) swung back to the northeast, but was then blown back to the southwest again, following a 14-hour period. Superimposed on the high water level, raised by a five-foot seiche, were the huge waves produced by the storm. It is no wonder that such tremendous destruction and flooding took place. It is only surprising that so many homes, of those built near the water's edge, survived.

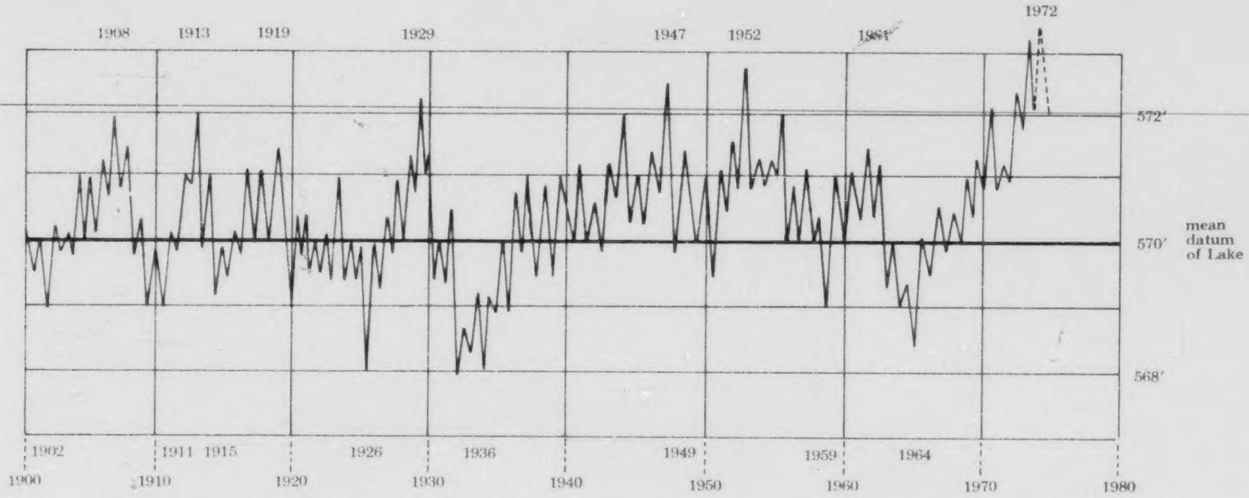
"How can such destruction be prevented? The best answer is not to build in such areas. Even though the lake level will begin to drop in another few years, it will rise again about 1994. For those with homes already built close to the lake shore, the only solution is expensive engineering structures, not just in front of one home (which would actually increase the wave damage), but all along the critical shoreline."

Environmental Education in the Watershed:

One of the most exemplary environmental education efforts in the state is a Cuyahoga River Watershed study by teacher-student teams from 12 schools in the area. The project was initiated in 1971 by the Cleveland-based, nonprofit Institute for Environmental Education, co-sponsored with the Cleveland Health Museum and Education Center and Cleveland State University. The purpose is to create a cadre of environmental science teachers and students to show other teachers, students and administrators how to incorporate environmental education programs into their curricula.

The meandering 103-mile long Cuyahoga, befouled in many places by every conceivable type of man's wastes, provides an unparalleled laboratory for testing water. Boys and girls in the eighth grade and up go to the banks of the Cuyahoga and its tributaries, bottle water, and take it back to the school laboratory and analyze it. Information gathered in the process is expected to provide useful data for the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers and the Three Rivers Watershed District. In addition students make analyses of soils in the watershed and pursue such cultural interests as making maple syrup.

A film, "Come Learn with Me," 16 mm, 14 minutes, sound and color, produced by the USEPA in conjunction with the Cleveland Institute for Environmental Education, shows how the project works and how similar programs may be started in schools. The film is available free on loan from Modern Talking Pictures, Inc., 160 East Grand Avenue, Chicago, Ill. 60611.



Elevations of Lake Erie, 1900-present, drawn from data published by U.S. Lake Survey Center in Detroit.

THE FIRESTONE TIRE AND RUBBER PLANT

Location: 1200 Firestone Parkway, west of South Main Street in Akron, Summit County.

A trip through one of the Firestone tire making plants provides an opportunity to observe natural and synthetic materials combined by man and machinery to produce a product essential to the safe mobility of people. The production is a study in resource management, air and water quality, energy uses, and recycling.

Harvey S. Firestone, an Ohio farmer's son, founded the company in Akron in the year 1900 to sell solid rubber buggy tires made by other firms. A highlight of the early years was the introduction of the solid rubber sidewire tire. In 1903 he started his own factory with 12 employees to make buggy tires. In the year 1910, Firestone bought 15 acres of land at the extreme southern edge of Akron. He moved the small factory to that location and gradually expanded the operation until now the facilities stretch along the Firestone Parkway a full mile. The complex includes a large administration building identified by the Firestone clock, a plant for the construction of truck tires, one for passenger car tires, a gas-fed electric generating plant to supply energy, a synthetic rubber plant to provide material for the tire formula, a modern research laboratory, computer center, a recreation building and other facilities.

The expansion of Firestone and the other Akron rubber companies coincides closely with the era of automobiles. Between 1900 and 1905 auto registrations rose from 8000 to 77,000 in the United States, an indication of the astronomical numbers of cars to follow. Autos required safe, comfortable and economical tires and the rubber companies put their staffs to work to meet this need. The transitions from narrow solid tires, to pneumatic tires with highly inflated inner tubes, to the steel radial tires of today, have taken place one step at a time. And research continues.

One of Mr. Firestone's novel ideas was to start his own rubber plantation, which he did in Liberia in 1926. To him goes credit for initiating the now popular one-stop service station, begun the same year. Rated as one of his proudest achievements was the start of his campaign to "Put the Farm on Rubber" with the development of the first practical, low-pressure farm tractor tire, which appeared in 1932.

The demand for Firestone products increased, causing the company to establish new plants in the United States and abroad and to diversify its products. It now makes 7000 styles and types of tires in 14 U.S. cities and 29 foreign countries.

In addition to tires, Firestone produces more than 40,000 diversified products in 43 U.S. plants and 22 foreign countries. These diversified products include metal products such as wheels, rims, containers, plastic resins, film and sheeting; polyurethane foam; rayon, nylon, polyester and steel tire cord; coated fabric products such as Fabritanks, Fabridams and synthetic rubber.

The company began research and experimental work on synthetic rubber in 1933. This proved to be of great value during World War II when the natural rubber supply from the Far East was cut off by Japan. The government owned, Firestone-operated synthetic rubber plant in Akron was the first in the country to produce synthetic latex in April, 1942. After years of research, Firestone discovered a process to produce a new rubber with the same x-ray crystalline pattern and molecular structural features found in natural rubber. They called the new rubber Coral, regarding it as a potential replacement for natural rubber which would make the United States almost entirely free from its dependency on the natural rubber of the Far East. However, 25 percent natural rubber is still used in car tires; a higher percentage in truck tires.

Conducted tours for school groups are usually confined to Plant One, which makes large tires for trucks, buses, trailers and tractors. In preparation for the experiences, students see a 26-minute film entitled "For Every Wheel that Rolls," the story of tire manufacture from test tube through design, development, testing and production.

Tire building is a complex process which begins with combining ingredients in a huge Banbury mixer. Natural and synthetic rubbers arrive in bales and are split into small pieces before they are mixed with chemicals. Various grades of rubber, blended to meet specific compound requirements, and exact amounts of carbon black and pigments are emptied from a conveyor into the giant enclosed machine. This device operates like a dough mixer, forcing the material through a pair of irregular rolls meshed together with a tearing, mixing motion for a prescribed length of time. After this operation, the batch drops into a pelletizer where it is cut into small marble-like pellets of uniform size and shape to facilitate cooling, handling and processing.

Sulphur and accelerators are added to the pellets in a final mixing process. Credit for discovering the value of sulphur must be attributed to Charles Goodyear, back in 1839. The all-but-useless gum or natural rubber turned into a leathery, tough, resilient substance when he mixed it with sulphur and dropped it accidentally on his kitchen stove. Goodyear had discovered vulcanization—a necessary step toward rubber technology.

Following the second mixing process the material drops into an automatic mill where it is rolled into a thick continuous sheet. A sample of each sheet is taken to the testing laboratory to be checked for strength and elasticity. If the compound is satisfactory, it is conveyed to a warming mill where it is kneaded and heated to make it workable. It then moves by conveyor belt to the machines which turn out the tire components — treads, sidewalls, plies and beads.

Firestone's textile plants prepare a cord fabric made of rayon, nylon, polyester fiber glass or steel. This finely woven cord material consists of the strongest possible strands woven with tiny cross threads to bind them together. In the next process, each filament of the cord material is thoroughly coated and insulated with a special compound, establishing a strong bond between the cord and the surrounding rubber. In perfecting this part of the process, tire manufacturers have greatly increased the service and safety of the product. The fabric then goes to a calender where rubber is pressed onto both sides and between the cords.

The rolls of fabric are then cut on the bias, diagonally across the cords, to specified widths and bias angles. These strips are called "plies" and they are spliced into continuous strips ready for tire assembly.

Strands of copper plated, high tensile steel wire, coated with rubber, are wound into circles or "beads" and sent with the plies to the final assembly. The tread and sidewall units, made with special compounds, are fed into still other machines, processed and coated with adhesive. These strips are cooled and are cut to the exact size needed for a particular tire.

All the parts are brought together for assembly, which involves the precision work of one man combined with semi-automatic machinery and a collapsible drum. Beads are placed in rings at the sides of the drum and an air-sealing innerliner of a special rubber compound is applied to the drum. Two or more bias-cut plies and a layer of the strong rayon, fiber glass or wire cord belts which encircle the tire body are wrapped around the drum under the tread. Small guideline lights above the tire assembler help him place the pieces at the precise spot. The assembler adds the tread and sidewall unit onto the tire and splices it securely to insure good adhesion. The tread splice is handstitched and the operator attaches a sticker bearing his number. Automatic stitching follows with rotating wheels forcing all air from the plies. The drum then collapses, and the "green" tire is removed, checked and conveyed to storage for curing — all this in a matter of a very few minutes. Hundreds of machines and men work around the clock producing tires. This is still the preferred method, although complete mechanization is under experimentation.

Looking like black barrels without tops or bottoms, green tires are sprayed with lubricants. Each is placed in a mold which looks like a waffle iron where internal pressure forces a curing bladder into the tire, shaping it like a doughnut. Steam heat inside the mold softens the rubber, forcing it into the nonskid pattern of the mold. Heat within causes a chemical change, or vulcanization, which fuses the many parts into an integrated unit. At the end of the curing cycle, which may be twenty minutes to more than an hour, depending on the size of the tire, the mold opens, the bladder collapses and the tire is automatically removed to go to final inspection.

Water is used extensively in the manufacture of rubber tires, primarily for cooling purposes and to create steam for curing tires. Water is obtained from the company's own wells which provide a steady supply from a rich aquifer in the area. In the winter when the water is cold, the supply is drawn from Summit Lake. Sanitary and drinking water are obtained from the city, which has several reservoirs. Four million gallons a month are used in one plant.

In the tire making plants, except for raising its temperature, water is used without contamination. In the manufacture of synthetic rubber, the individual waste water discharges are treated in an advanced air flotation clarifier system to remove contaminants before discharge into the city of Akron sanitary system. This air flotation clarifier system, which more than meets the city code, was installed in 1970.

The company has its own generating plant which meets most of its electrical requirements, although some is purchased from Ohio Edison. With fossil fuel limitations approaching, energy may become a problem.

Firestone researchers have been gaining recognition for their efforts to recycle old tires. (*The Environmental Monthly* 4/71). Work is being conducted on a process called "destructive distillation" or pyrolysis, where old tires are heated at high temperatures and transformed into various and separated chemical components. Fifty chemicals have been identified, mostly heavy and light oils, carbon black, steel and gaseous fuel.

Firestone is recognized for its handling of the carbon black used in tire making. The fine material is confined in containers and pipes so effectively that practically no air contamination is possible.

Tours are restricted to sixth grade students and above. Prior arrangements must be made. Contact: Department of Public Relations, The Firestone Tire and Rubber Company, 1200 Firestone Parkway Akron, Ohio 44317, Phone (216) 379-7000.

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Clock Tower, Firestone Tire and Rubber Company

THE GOODTIME II CRUISE OF CLEVELAND HARBOR AND THE CUYAHOGA RIVER

Location: East 9th Street Pier, Cleveland.

There is a unique excitement in going to a major international harbor which transports goods to many parts of the world. The Cleveland Harbor and Cuyahoga River cruise vividly demonstrates how man in his desire for material goods has raised his standard of living, yet unquestionably affected the quality of his environment. The cruise gives an opportunity to experience differences in air and water quality, to witness resource management and to consider alternatives in land use planning.

One of the early experiences on the boat is to see the place where Moses Cleaveland and his small party of surveyors landed at the mouth of the Cuyahoga in 1796 and decided to establish a pioneer village. His three log cabin settlement struggled to survive on a mixed economy of flour, salt, pork and whiskey. It was not until the opening of the Ohio Erie Canal System and the discovery of iron ore in Michigan that Cleveland experienced rapid growth.

Throughout the mid-1800's the harbor bustled with steamers carrying passengers and goods, much of which was iron ore from Michigan and coal from Appalachia. The early 1900's found the steel industry thriving vigorously with more diverse products introduced in rapid order. Fishing, oil refining, cement mixing and wine making accompanied the growth of the steel industry. Primary metal manufacture, transportation equipment, machinery, fabricated metals, paper and its products, ordnance and scientific instruments gradually became the industrial giants of the city. Railroads and canals were essential developments, but the harbor and the river have been the scene of industrial dominance.

As one approaches the harbor to board the Goodtime II for the trip up the Cuyahoga River, seagulls and terns gracefully fly above the expanse of Lake Erie as its waves crash against the breakwall beyond the busy harbor. From the pier the lakefront stadium comes into view. Far out on the horizon huge ships freighted with goods from the other side of the world pass by.

As the Goodtime carries its passengers from the windy harbor into the Cuyahoga River valley they feel an immediate change in temperature as the shale banks rise on either side to quell the winds to a gentle breeze. The air is tinged with the fumes from a steel mill and oil refineries. The water below is murky and obviously devoid of life. The scene establishes an acute awareness of how history, economics and people have generated an exciting, yet in many ways, a deteriorated environment.

The diesel ship Goodtime is a triple decker delight for any child, parent or teacher. The huge boat, which often carries as many as 200 children representing several school districts, is neatly painted bright blue and white. Its bass horn toots as it backs slowly into the Cleveland harbor. A taped narration directs attention to the tremendous variety of industries densely packed along the edge of the river. The greatest emphasis is upon the making of steel, the raw materials required, and the process by which it finally emerges from the hot furnaces of the Republic Steel plant. The backyard of ship building, the Sherwin Williams paint factory, the Sinclair Oil refinery and many other major industrial sites are quite visible and arresting. This great industrial complex gives a convincing reason for the rapid growth of Cleveland through the years from Moses Cleaveland's simple pioneering village to one of the largest industrial and cultural centers in the Midwest.

The ship passes in front of the "flats" area where passengers view the old warehouse district, which has been restored recently to make a night club section despite the old B & O trains which still rumble through daily.

The great prosperity generated by industry in the Cleveland area has made its mark on the environment. The plants and the population concentration have contributed tremendous quantities of liquid wastes to the river waters. Tons of pollutants from smoke stacks have emitted stench, gases and particulates into the atmosphere. The lake suffered the same fate. It has been only in recent years that citizen protest, federal, state and local action have resulted in changes which are beginning to show on the cruise of the river and lake.

The Goodtime II plies its way up the river for three miles, each mile revealing a variety of industrial complexes, many different types of bridges and more of the contaminated river water. Regardless of the environmental defects, the trip is fun and informative, giving unforgettable impressions of a wide variety of environmental stimuli.

Groups of any size are handled but the tour is best adapted to elementary level classes. Tours daily, April 20 to September 30. Reservations should be made two months in advance. Fee is $1.00 per child, teacher free. Contact: Goodtime II Cruise Line, 150 East 209th Street, Cleveland, Ohio 44123.

A reinforcing experience to follow this trip is a tour of the Republic Steel Plant. Arrangements may be made with the Public Relations Representative, P.O. Box 6778, Cleveland 44101, phone (216) 574-7686.

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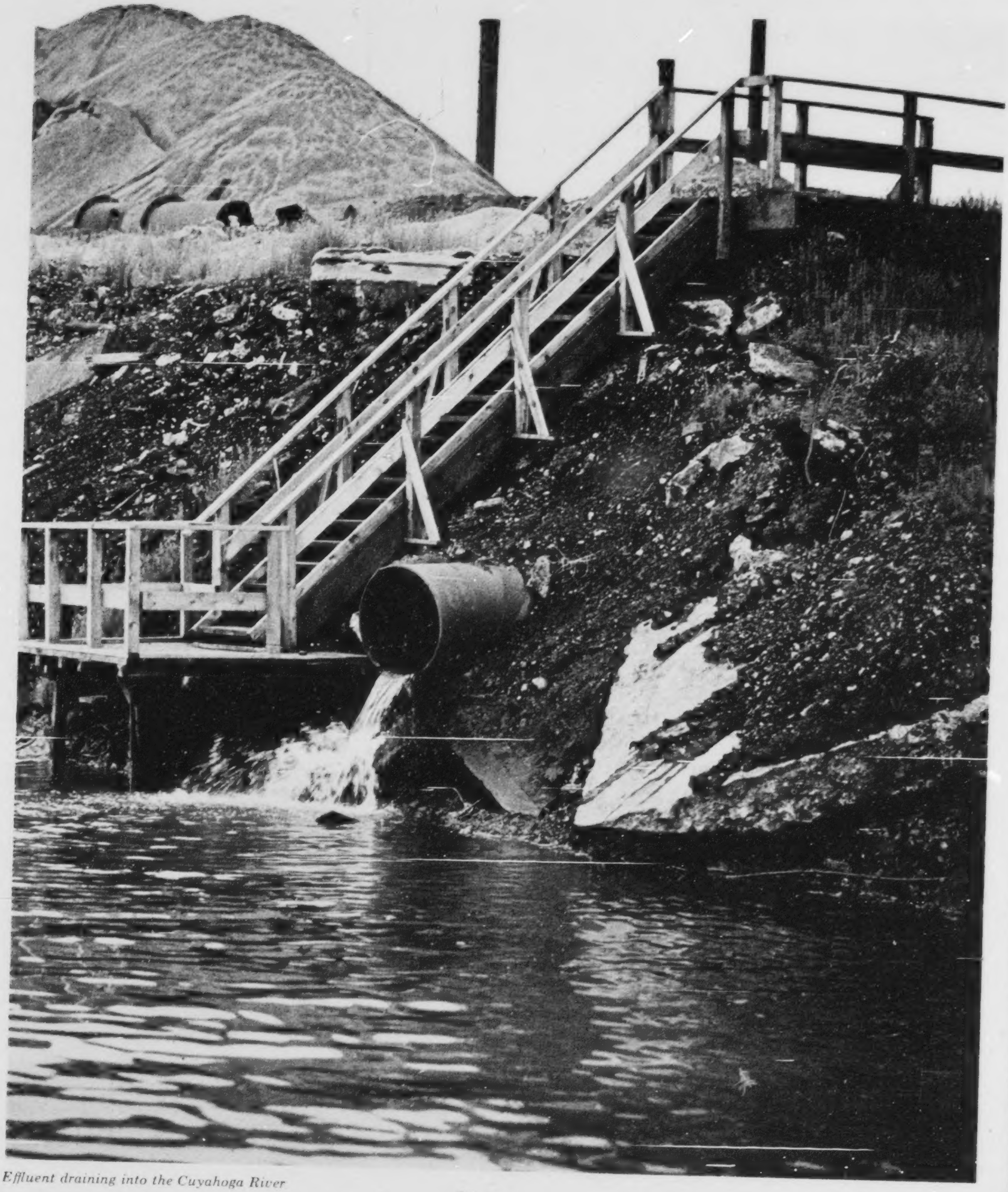

Effluent draining into the Cuyahoga River

HALE FARM AND WESTERN RESERVE VILLAGE

Location: 2686 Oak Hill Road, Bath Township, Summit County. From north and south, follow signs from I-77, Richland-Peninsula exit; from east, exit I-271 at SR 303 and follow signs.

The Jonathan Hale Farm and the restored Western Reserve Village are the results of the efforts of the Western Reserve Historical Society of Cleveland to preserve the rich heritage endowed by the early settlers in the Reserve. It is an example of wise land use planning and reclamation.

The site lies in the glaciated Allegheny Plateau, underlain with Mississippian age sandstones and shales. The stream, a tributary of the Cuyahoga River, and weathering processes have effectively eroded through the glacial till and the bedrock to form fairly rugged topography. The surrounding area has many wooded hillsides and deep ravines with attractive homes and farmsteads dotting the terrain. The original vegetation was a mixed hardwood forest, and the present wooded areas with a large number of virgin trees and new plantings reflect both succession and the original vegetation. The Hale property shows plantation plantings of conifers; majestic white pines, tamarack and spruces, perhaps planted soon after settlement, add charm to the homestead area.

The story of Jonathan Hale, a tall, sturdy farmer from Glastonbury, Connecticut, who purchased 500 acres of Western Reserve land to begin a new life, is typical of many settlers in the area. Traveling in a covered wagon containing basic equipment, he arrived alone in 1810, only to find his land occupied by a squatter, a situation not too unusual in the early days of Ohio. The intruder, although illegally established, had cleared several acres of land and had built a log cabin. Jonathan, a fair man, knowing that his family soon would arrive, gave his horses and wagon in exchange for the work already accomplished. The log cabin was to be the Hale home for the next 16 years.

In 1826 Jonathan began his red brick house, making his own brick, quarrying the stone and cutting the large oaks for the heavy beams. The structure was one large room at the outset where all the family functions were performed. Gradually, a large dining room, parlor, and bedrooms were added above in two stories. All the rooms are now effectively decorated in a manner reflecting the gradual affluence and size attained by the Hale family.

An early barn on the property now houses the craft shops—spinning, weaving and wood working; a candle making room is on the lower floor of the brick house. The blacksmith shop is the scene of horseshoeing when the need arises.

More than a century after Jonathan Hale's death, his great granddaughter, Clara Belle Ritchie, bequeathed the Hale farm to the Western Reserve Historical Society to preserve the property and to perpetuate the cultural heritage typical of the settlement days. In keeping with her will, the property was opened to the public in 1958.

Across the road from the Hale House is the restored Western Reserve village. The buildings are all original buildings which have been moved from various places in the Western Reserve, where they were in danger of being destroyed. The "Saltbox House," a name given to the characteristic New England home with a lean-to at the back, resembling the hinged lid of an old wooden saltbox, was built in 1830 and moved from nearby Richfield in 1962. It is authentically and charmingly furnished as its owners of that period may have done.

Down the street is the Greek Revival house, built in Bath about 1845, and a neat home built in Stow about 1850. Beside the stream in the shade of a pine hillside is the Log Schoolhouse, built near Youngstown about 1816. Originally a farm house, it was converted first into a Catholic church, then into a parsonage, then back to a farm house. After its last occupants abandoned the one room structure, it was moved to Bath to become a schoolhouse. Its furnishings are reminiscent of the rigors of early school life.

The Benjamin Wade Law Office, built about 1825 in Jefferson, appears to be just as the congressman left it, books, fireplace, quill pen and all. A Meeting House, built in Streetsboro in 1852, is being restored. A grist mill, necessary for "convenient" living, was usually erected early in the growth of a community. One built at Newton Falls around 1851 completes the present reconstructed village.

In addition to guided tours through Hale House and the Western Reserve Village, classes have an opportunity to see cattle, horses, pigs, geese and sheep in the pastures, fields of Indian corn, flax, wheat and pumpkins, and a large barn. Craftsmen in the costume of the period demonstrate carding wool, weaving, wood working and candle dipping. Other craft specialties are shown on festival days.

Special arrangements make it possible for small groups, college level and below, to live in the Hale House for a short period of time, just as the Hales lived almost a century and a half ago.

Facilities include parking, restrooms, picnic tables, snack bar, gift shop. Hale House is open May 1 through December 31, Tuesday through Saturday, 10 a.m. to 5 p.m.; Sunday, 12 to 6 p.m. (Closed Mondays). Regular fee is $1.50 for adults; 75 cents for children. For school groups — 50 cents each. Reservations must be made prior to visit. Contact: Manager, Hale Farm and Village, Peninsula, Ohio 44264. Phone: Akron (216) 666-3711, Cleveland (216) 861-4573.

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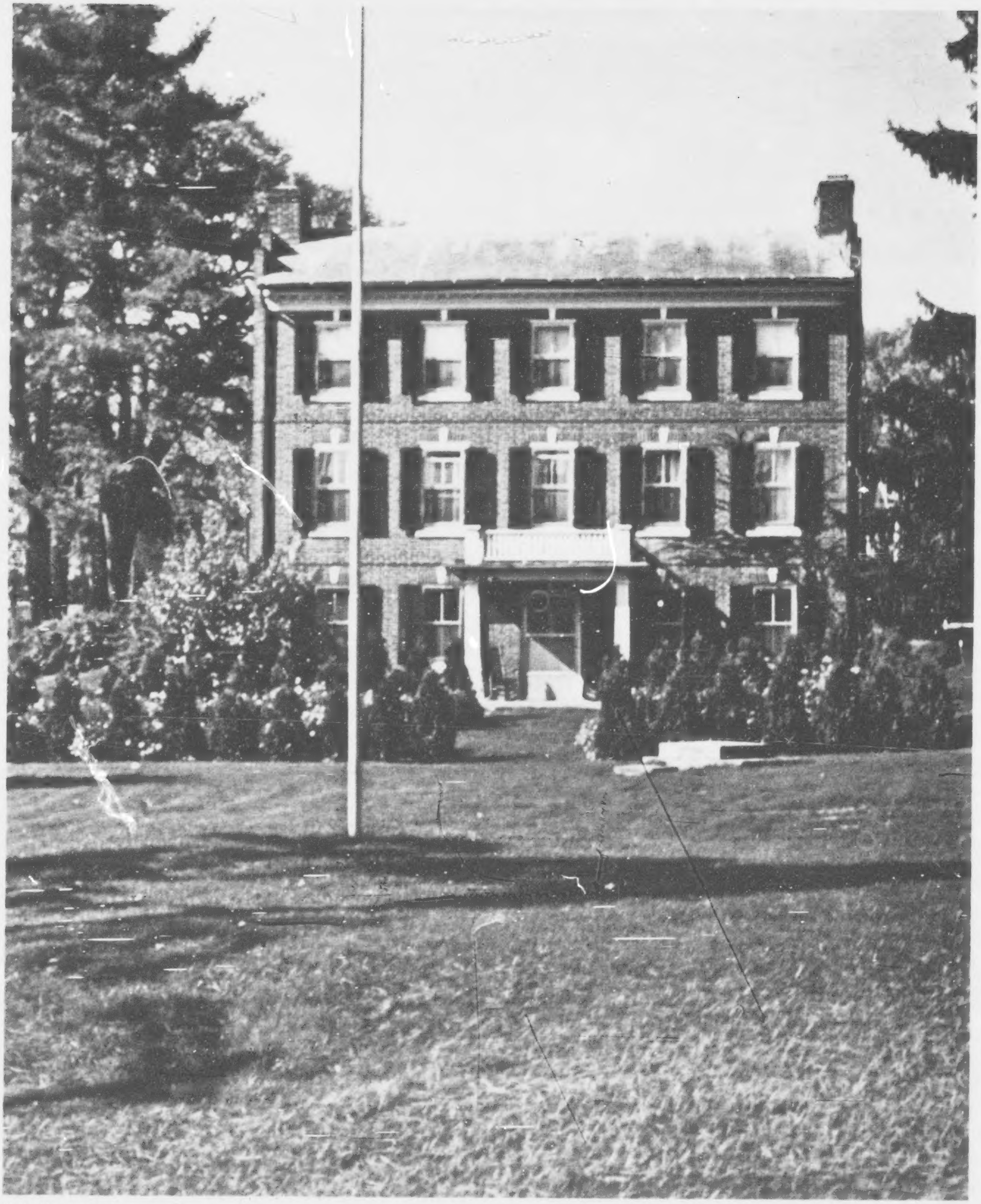

Hale Homestead

HAYDEN AVENUE NEIGHBORHOOD DEVELOPMENT PROGRAM

Location: 10 miles east of downtown Cleveland, turn left on Doan Street just beyond the Rapid Transit Station, take Doan to Hayden, East Cleveland, in Cuyahoga County.

The Hayden Avenue Development Program is a pearl amidst the perceptions of blight and negativism too often found in large cities. The project combines the hopes and desires of people in a small community with professional planning skills to confront problems of deterioration in their environment. They have been faced with poor housing and a lack of creative cultural and recreational opportunities. Positive actions directed to improve their neighborhood in a comprehensive way are coming to fruition. A tour for observation and a study of the procedures followed in attaining the goals can provide students with a direct experience in community planning and reclamation.

Since the turn of the twentieth century, East Cleveland has been a stable, attractive, residential suburb. In recent years, however, two major changes have greatly affected the community. The first came from the natural process of aging; signs of deterioration of buildings were evident in the late 40's and 50's. The second change was more dramatic. During the 1960's East Cleveland experienced a rapid shift in its racial make-up. As housing became available, black families moved into a previously all-white neighborhood. The process was quickly accelerated by panic, capitalized upon by block-busting tactics. Block after block underwent rapid change during this period.

By 1967, East Cleveland faced some serious problems. There was an air of deep concern in people aware of the changing situation, and in some quarters there was despair about the community's future. Absentee ownership was increasing. Many citizens were moving out. The steady in-migration of new residents was bringing new problems for the city government, schools, and neighborhood organizations. Real estate agents seemed to write off the city. Banks and other lenders refused to finance investments. Sources of local revenue were drying up and a proposed freeway threatened to demolish homes, displace hundreds of residents, and further erode the tax base. These conditions stimulated the city to begin planning for renewal in 1968. Application was made to the Federal Housing and Urban Development Agency for a grant under the Neighborhood Development Program (NDP). In 1969, East Cleveland became Ohio's first renewal program to be funded with NDP monies. Immediately, a representative body of citizens gathered to help make the important decisions for the future of the community. Their first priority was a 48-square-block area of the Hayden Avenue neighborhood.

It is difficult to imagine the Cleveland of settlement days as one walks down the mile-long section of Hayden Avenue. The city was built on the old glacial lake bed of a former level of Lake Erie. It was covered with a dense forest which disappeared gradually as the streets were developed. Large sycamores forming a graceful arch above several adjoining streets are the only remnants to protect residents from the heat of a long summer day.

Hayden Avenue is a major commercial strip in East Cleveland. The racial changes and aging took their toll on this street, for it has been unable to keep many old businesses and is at a loss to attract new ones. Many of the houses and shops along the thoroughfare threaten to blight the remainder of the project area. In the residential section, two-family clapboard homes dominate. Each home is a bit unique to its neighbor. Colors range from white to bright red, and designs vary from peaked-roofed, two-story homes built 70 years ago to the more modern one-level ranch style. Yet there are striking similarities in that most homes have very narrow side drives and small, but manicured lawns.

A most casual look at the community reveals many examples of planned change aimed at meeting human needs. The new moderate income housing units on Doan Street provide economical and attractive homes with obvious consideration given to residents and their need for green space. Exciting creative play structures, built of stacked railroad ties on the school playground, stimulate children to free their imaginations during playtime. Deteriorated and dangerous buildings were razed and replaced with a mini-park where tricycles can safely race and mothers can relax from their daily chores. Vacant spaces now await new homes and shops.

The project is still young, so the total change has yet to emerge. What is most unique about these changes is that each is part of a comprehensive plan to bring into balance the economic as well as the social, recreational, and educational fibers of the community fabric. The plans result not from the mind of one or two planners but rather from several years of involving citizens in defining their community's direction. This basic process of participation has given residents a new sense of identity with and responsibility for their community, apparent in the care they give to their homes. This milieu is critical for keeping the community stable. The essential fact for youth to observe is that change can happen.

Groups of 30 to 60 students in junior high grades and up are welcome. Three to four weeks advanced notice is requested.

Contact: Director, Hayden Avenue Neighborhood Development Program, 14340 Euclid Avenue, Room 210, Cleveland, Ohio 44112, Phone: (216) 681-5020.

INDEPENDENCE SCHOOLS OUTDOOR EDUCATION CENTER

Location: Independence, east of SR 21 at 7733 Stone Road, adjacent to the Cuyahoga River valley, Cuyahoga County.

This relatively small acreage (49.2 acres) with its outdoor classroom facilities and habitat development, its preserved natural area, and its proximity to the Cuyahoga River enveloped in an industrial area, is an excellent example of land use planning and resource management. It provides, also, an opportunity to study the water quality of the river and a tributary on the property.

The geological forces which have shaped the landscape in all parts of the planet have been at work in the Cuyahoga. The area lies on the southern extension of the Canadian shield, one of the largest continental buttresses on earth composed largely of igneous and metamorphic rock and dating back four and one-half billion years. Great inland seas encircled the shield; rivers flowing from it brought extensive sediments into the waters. The seas encroached and receded at intervals through geologic time, and the land rose and was exposed to precipitation, freezing and thawing, the processes of weathering (breaking down the rocks), and erosion by the streams, large and small, that carried the water and its sediments into another sea. In the Paleozoic Era of geologic time, the Devonian and Mississippian periods, 400 to 200 million years ago, the sedimentary shales and sandstones, in evidence in the ravines, were sediments in the sea which were compacted, uplifted and eroded. Only one million years ago the glaciers came, scraped their way across the area, leaving a mass of sand, gravel, boulders, clay, and rock flour called glacial drift on the surface of the land. Vast quantities of meltwater flowed from the mile-high ice mountain as it wasted back. The present Cuyahoga River valley was shaped during this period. The tilt of the land toward the Lake Erie basin and the easily eroded shale layers determined the direction of flow and the present contour.

Enormous animals—mastadons, bison, giant beaver, elk and woodland caribou—roamed the valley when the ice melted back. There is archaeological evidence of the appearance of prehistoric man during this era. Indians followed; the Iroquois nation extended into the area. After the French and English, who were the first white men to explore the valley, had been eliminated by war, and the Indians were pushed aside by the Treaty of Greenville in 1795, the early New England settlers bought land in the Western Reserve and the area began to develop.

The land wasn't particularly hospitable. The river periodically spilled over its banks, leaving marsh and swamp areas that bred millions of mosquitoes. Roads were muddy, settlements were far apart, and the land difficult to farm. It wasn't until the Ohio-Erie Canal opened the area for commerce and industry that the present era of prosperity and population began.

The land now used for the Independence School Outdoor Education program was farmland. Either by design or circumstance a virgin stand of forest was left untouched. The good German farmers cared for it until in the middle 1950's when it became a Nike site in the Cleveland Defense Area. Eventually, like other Nike sites, this one was abandoned and reverted to the General Service Administration. The school board was notified that the site would become surplus government property. Then began a period of hope and frustration on the part of those who envisioned the site as a potential outdoor education laboratory. The property was made available in 1967, a Title III grant was received for developing a land laboratory program, and the present development began.

There are four natural divisions within the site, each showing vegetational and topographic differences:

1. The Upper Slope, upon which the facilities and major part of the center lie. Evidence suggests that this area was one beech-maple forest with a higher percentage of oaks represented along the area designated as ridge.

2. Ravines, much of which lie outside the land laboratory, described as having a maple-oak vegetation. Numerous large trees of tulip, white ash, shagbark hickory, cucumber tree, basswood, buckeye, American elm, and wild black cherry are present. An understory level supports ironwood, hop hornbeam, spicebush, witch hazel, maple leaf viburnum, sour gum and sassafras. Due to the rugged topography, the vegetation of the ravine area is comparatively the least altered of the four divisions.

3. Flood plains embrace the area along the east bank of the river and a jutting loop caused by an oxbow in the river. The vegetation is largely a cottonwood-maple community, the maples being silver and boxelder. Black willow is present throughout. More species are common in the north-northwest section than in the south-of-the-river loop area. These include sycamore, Ohio buckeye, black ash, red elm, white ash, black walnut, butternut, wild black cherry and red mulberry.

4. West Bank designates a steep northeast facing slope west of the river. The slope is 30 percent, but despite topography, soil is deep enough to support a mature forest. The present vegetation is an oak-maple forest with many species of the north flood plains part of the association. The original forest cover was probably similar to the present one in species composition. Sugar maple and American beech may have played a more dominant role.

A walk along the guided trails shows a meadow succession, woodland with abundant wildflowers in sea-

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son, and leads to the Cuyahoga overlook. Here is a spectacular view of the forested areas as well as the Cuyahoga River, a stretch of the old Ohio-Erie Canal beside a modern four-lane highway, power lines and an industrialized valley. A narrow trail leading from the overlook gives an opportunity to see northern relict plants—huckleberry and trailing arbutus.

Over 80 species of birds have been recorded and a variety of mammals seen. Two ponds were imposed on the upper slope to furnish easily accessible pond-life habitats. Frogs and turtles abound; birds seek the water, and a multitude of micro-organisms can be studied.

In 1972 the teachers and high school students formed an Independence branch of the Cuyahoga Watershed project sponsored by the Cleveland-based Institute for Environmental Studies. (See Background Information.) Workers are divided into crews which make water quality tests in relation to weather conditions. Dams on the small streams were constructed to get accurate data on normal flows and in heavy rains. Teams have done weekly monitoring and researched discharges into the streams.

Total school and community involvement in the project from the outset has been one of the gratifying developments. School board and administration support has been constant and effective. Federal support in giving a portion of the land and the Title III grant were essential. Teachers, students, community clubs, local government, parents and friends combined their efforts to make the project a success. Other schools have studied the methods and evaluated the results in order to establish their own laboratories. The recent coalition with the Institute is providing impetus for more research, for input of student research to a large information pool, and for strengthened bonds with other schools in the program.

The school continues to invite teachers and classes to visit and study the site with its great variety of habitats and to examine its environmental research efforts.

A classroom on location, a small museum, a shelter, indoor sanitary facilities, parking and water are available for as many as 40 persons. Visits are preferred during school hours but arrangements may be made for summer activities. Contact: Director, Independence Schools Outdoor Education Center, 6111 Archwood Road, Independence, Ohio 44131, Phone: (216) 524-4124.

Bloodroot (Sanguinaria canadensis)

LAKE ERIE JUNIOR NATURE AND SCIENCE CENTER

Location: Huntington Park Reservation of the Cleveland Metropolitan Park District, 28728 Wolf Road, Bay Village (Cleveland), off US 2 near the Cuyahoga-Lorain County line.

This center, because of its location on a polluted lake and stream and proximity to two highly urbanized and industrialized areas, is outstandingly valuable as a study area. It is also nationally recognized for an environmentally related education program in a reservation where natural habitats have been preserved. Land use planning involving preservation, resource management, air and water quality, and population studies may be pursued.

Prior to the procurement of the Huntington Park Reservation by the Cleveland Metropolitan Park District, this portion of the "Emerald Necklace," the name applied to the ten major reservations and parkways encircling greater Cleveland, was the summer estate of millionaire John Huntington. To him goes a tribute for not only setting aside many acres of woodland along the shore of Lake Erie but for his development of an arboretum. He planted many exotic trees and ornamental shrubs which now contribute to the feeling of mature beauty and enduring quality of the place.

The idea for the Lake Erie Junior Nature and Science Center was conceived by a far-sighted woman who worked out her own training program to bring the idea to fruition. In the early 1930's, Elberta Fleming, assisted by Anna Billings Galup of Brooklyn, N.Y., founder of the first children's museum, outlined a course of study and action. Ms. Fleming took courses at Wooster College and OSU's Stone Laboratory on Lake Erie in preparation for the opening of a children's museum in Bay Village. The program grew and gained support; its trustees and Ms. Fleming arranged to build a new structure on land belonging to the Cleveland Metropolitan Park District. The facilities and program have expanded to the point of a half million dollar investment and a broad-based program with 12 full or part-time teachers.

The study area, situated on the shore of Lake Erie, is underlain with the Chagrin and Cleveland shale formations, bedrock of Devonian age. The rock layers are covered over with lake clays representing an early stage of Lake Erie. This area is drained by Porter Creek which has dissected the land surface to form deep ravines favoring glacial relict vegetation such as hemlock and associated species. Remnants of the original mixed oak forest remain with a wide variety of wild flowers growing on the forest floor. Flood plains, swampy areas, and open fields in succession provide various plant communities for study purposes.

Woodland, field and waterfowl species of birds may be observed. During migration large concentrations of water birds stop on the lake. Raccoon, opossum, deer, skunk, and muskrat remain in their favored habitats regardless of the nearness to highly populated, urban areas. Fox tracks, too, are observed.

The children's museum in the main building has a variety of animals which students may touch. Also there are outdoor cages, and a white-tailed deer run.

A comprehensive program of physical science and nature activities centers around the living museum, a planetarium, weather station, classrooms and the 105 acres of land encompassing lake shore, woodland, open fields, flood plains and streams. A series of units is planned each school year designed to supplement and fortify the curriculum for kindergarten classes through sixth grade. New programs are being planned for seventh grade and above. Physical science units include geology, the physical and chemical properties of atoms and molecular forces and motion, simple machines, and electricity. Sixth grade units treat sound, light, aerodynamics, astronomy and meteorology. Nature walks and field trips give young children an introduction to nature with units on baby animals both domestic and wild, survival of wildlife, trees and shrubs of the Huntington Arboretum, bird life and migration, flowering plants, pond life, and reptiles and amphibians.

As classes of all ages explore with trained teachers the natural environment, they encounter on every hand man's impact upon their world. They see that the only swimming beach on Lake Erie available for miles is monitored frequently and sometimes closed due to the pollution levels. Creeks feeding into the lake are objects of research. Older students might be challenged to test the water in Porter Creek to determine its content and determine methods of analysis. Waste-water treatment plants in the area are inadequate for secondary treatment and storm sewers flood the systems on occasion. Nearby industrial power and chemical plants add sulphur oxides and fly ash to the atmosphere. High school students are monitoring the air pollution.

The availability of the center with its superior programs gives schools in the area a tremendous advantage in developing a generation of students who appreciate the fascinating world of nature and yet are aware of the environmental problems which endanger it.

Parking, sanitary facilities, nature trails, and picnic tables are available. All nature hikes or field trips are limited to one school class. These trips are one-and-a-half to two hours in duration. Charge for each program is $30 per class of 30 students or less; $1 per student over class of 30. Contact: Registrar, The Lake Erie Junior Nature and Science Center, 28728 Wolf Road, Bay Village, Ohio 44140, Phone: (216) 871-2900.

THE MARSH RUN WATERSHED

Location: South of US 224 in southwest corner of Huron County around Celeryville.

This site provides a study in water management and land use planning for 3000 acres of drained swampland made into Ohio's "Salad Bowl" by Dutch farmers.

The large acreage considered in this study was a former glacial lake bed called Lake Willard. When the ice sheet wasted back, a north flowing stream was impounded between the accumulation of glacial material on the south, recognized by glaciologists as the Fort Wayne recessional moraine, and the ice front. The lake was maintained by a moraine formed on the north which marked a long halt of the ice. Through the ten thousand years since the ice sheet retreated, the lake was gradually filled, first with clay, which was held in suspension in the glacial waters, then peat, the accumulation of vast quantities of grass and emergent vegetation which grew each year along the edges and finally across the lake bed. Water stood in the freshwater marsh during the summer to a depth of one to three feet even at the time the first Dutch farmers arrived to till the fields. The underlying rock strata is Ohio shale, a type of rock through which little water can penetrate. The area has one stream called Marsh Run which drains into the West Branch of the Huron River. The soil is a deep muck mixture with as much as 70 per cent organic matter, as compared to about three percent for the average residential lawn. It oxidizes rapidly, and when dry blows away readily, creating serious dust storms. Land owners expect to lose about a half inch every year. It also catches fire readily and the area has known severe and long periods of burning.

The flat Celeryville area was undeveloped until 1874 when some optimistic promotors attempted to drain the land. Little was achieved until the 1890's when a group of Dutch immigrants, who had first settled in Michigan, became interested in the rich soil reportedly available in Ohio. Several families bought small acreages of the muckland, the soggy land buried in some places beneath three feet of water. With typical Dutch determination, the newcomers combatted cold winters and hot summers, floods and droughts. They drained the swamps, built hot beds and greenhouses, and they planted their celery. The twenty-one families there finally enjoyed some good years, although capricious weather still made crops uncertain.

Flood control in rainy seasons and water supply in dry ones were finally guaranteed the farmers through their own planning efforts and the Northwest Ohio Water Development Plan. In 1953 the Celeryville Conservancy District was formed, as provided by Public Law 566, and implemented by the U. S. Department of Agriculture and the Soil Conservation Service.

Thirteen years later, a system of waterways and dams, with a huge 75-acre upground reservoir, was established. Marsh Run and its little tributaries were stripped of their vegetation, deepened, straightened and widened to manage the water resource. Four rubber dams were installed in the main channels to hold back water for irrigation. Deflated, these balloon-like dams, made of heavy nylon fabric coated with weather-resistant synthetic rubber, permit flood waters to pass quickly through the system.

Small dams with removable boards help control the tributary channels. Water is pumped through tile lines directly to the fields as needed. A device known as a stopwell is a part of each tile drainage system. By means of this box the level of the water table is regulated. Water can be drained out of the field to make it dry enough to till while the lower strata are kept wet to slow down oxidation. As dry spells occur, water can be added to the field by pumping from the irrigation canal into the stopwells, which distribute the water through the tile lines.

The huge upground reservoir was built for water storage. It is not a dam holding back the water in a stream although it is connected to Marsh Run. Water is pumped into it from the upper reaches of the stream, especially in times of excess, and it feeds the stream with a steady supply for irrigation purposes.

Prior to the completion of this watershed project the vegetable crop amounted to about one million dollars. Today the value of vegetables produced exceeds four million dollars. The crops produced are still celery, acre upon acre, plus mountains of onions, beets, spinach, escarole, carrots, radishes, lettuce, tomatoes, cabbage; and on one farm, the traditional corn, soybeans and grain. The peak export month is August, when 30 or more truckloads of potential salad materials leave Celeryville daily, headed for markets in Chicago, St. Louis, Little Rock, Arkansas, or Boston. Celery is started from seed in greenhouses and is transplanted later in the field. It matures in about 70 to 80 days. Radish seed is drilled directly into the field and the crop is ready for harvesting within 24 days if the weather is warm.

The twenty-one original Dutch families have consolidated into four or five major enterprises. These are operated by relatives of the early families, sons and brothers and cousins working together. In 1966, the 250 residents of Celeryville were all related except the pastor and the school principal.

Modern machinery plants, picks, sorts, weighs and packages much of the produce. In spite of this, growers find they still need nearly as many seasonal workers as before because of increased production. Most of the laborers are Mexican-Americans who winter in Texas. Many of the same people come back year after year, bringing their families to live in houses provided by the growers. A few stay the year around.

The total cost for the construction of the reservoir, the two 60-horsepower pumps to fill it, the drainage structures and automatically controlled coliapsible dams for flood control, and the widening and deepening of all channels and ditches was $1,350,000. The federal government is paying $800,000 for the drainage improvements. The other $550,000 is assessed to the land owners on the Conservancy District watershed. The costs will be determined on the basis of one-tenth of the estimated benefits, considering the life of the land. Benefits for irrigation are estimated to average $2400 per acre for the life of the land. Benefits for drainage and flood control are difficult to estimate, but it is conceivable that this will equal or exceed the irrigation benefits. The demand for fresh vegetables continues to grow, which would seem to guarantee the need for a constant supply. The Celeryville farmers, with the help of the Soil Conservation Service, maintain a high quality product and keep the cost to the consumer as low as possible. Modern refrigeration, improved seed varieties, better disease control and automation, together with the highly productive soil and irrigation, promise a continuous supply.

Located near the village of Celeryville on 15 acres of muck land, a branch of the Ohio Agricultural Research and Development Center experiments with varieties of vegetables to determine the best seed and method of production suited to this particular soil and climate. It tests disease resistant features, effects of various herbicides and other relevant factors. The substation, managed by a cousin of the Dutchman who regulates the drainage system, provides answers to many puzzling questions about the vegetables and the muckland on which they grow.

The Marsh Run Watershed in appearance provides no scenic, aesthetic features unless one appreciates broad, black fields yielding lush green vegetables and neat Dutch farmsteads. The straight channels are devoid of vegetation and trees are found infrequently. The water in the ditches is muddy and has little aquatic life. The effects of the periodic, fast flowing, flood water upon the parent stream are not calculated. But the people who live in Celeryville are contented and prosperous and consider their lives greatly enhanced by the water management developments. The amount of soil which normally oxidizes and erodes away has been minimized by the system; fires which formerly caused extensive losses no longer occur or are extinguished quickly because of the availability of water. The quality of the soil will gradually diminish. But on this flat, featureless glacial lake plain, man seems to have recognized his natural environmental limitations and found a way to cope with them.

For visits, contact: Jordan Holthouse, R.F.D., Willard, Ohio 44890, Charles Hanline, Stambaugh Farm, Plymouth, Ohio 44865, or Muck Branch, Ohio Agricultural Research and Development Center, Plymouth, Ohio 44865.

METALS PARK

Location: Off SR 87 east from I-271 at Russell, in Geauga County.

The world headquarters of the American Society for Metals is an exciting visual encounter combined with an impressive educational experience. A huge geodesic dome, the arc of a great circle, constructed from aluminum tubing and almost obscured from the highway by the gentle down-contour of a grassy hill, strikes the eye as an unreal figure from outer space. In addition to the dome there are a garden of metals, a jet fountain, very modern buildings providing a unique headquarters and educational facility, and 500 acres of choice beech maple forest surrounding the complex. These provide an opportunity to study resource management and land use planning. Fortunately, the park includes protection and preservation of an outstanding natural area.

The area lies in the glaciated plateau region which marks the beginning of the Allegheny foothills. It is underlain by Mississippian sandstones and shales dissected by a branch of the Chagrin River. The glacial soils are deep, strongly acid and fine-textured, the topography rolling to steep. The original vegetation was beech maple forest on the upland and well drained slopes. Elm, ash, soft maple and many related species were present in the flood plains. This particular site is reported to be one of the best beech forest remnants left in the northwest Ohio region. Campers and hikers from community youth groups are granted permission to utilize the forested area.

Metals Park was opened to visitors in August, 1959. It developed in response to the American Society of Metals' need for a headquarters away from urban distractions where the symbol of the world of metals and materials, from the raw elements of the earth to man's technological achievements in using the elements, could be fully developed. It was the dream of a founder-member of the society and its national secretary for 40 years, William H. Eisenman, who donated 100 acres constituting his summer home to locate the headquarters advantageously. He lived through several stages of development but never to see the completion of the project.

Four hundred acres were added to the property to provide for additional buildings which are a part of the long range plan for development.

The dome itself was designed by R. Buckminster Fuller, a prodigious inventor of such things as houses that fly and the Dymaxion Car. Since his creation of the geodesic structure in 1947, more than 3000 of them have mushroomed in over 50 countries, making this his best known achievement.

The famous geodesic dome is a network of hexagonal and pentagonal shapes formed from 13 miles of aluminum tubing and rods in tension. The structure is 11 stories high, has a base diameter of a football field and, in spite of its use of light metal, weighs 80 tons. It is mounted on five foundation structures which extend 77 feet beneath the surface.

The symbolization of metals is seen also in the expanse of perforated stainless steel which provides a sunshield. Stainless steel is used in the building in the main stairway, and in many other places, as planned by the architect, John Torrence Kelly, of Cleveland. Copper metals form ornamental screens, definition for suspended ceilings, and art creations. The entire building is supported by steel columns. Metals are everywhere in the building, from aluminum window casings and steel doors, to the smallest detail. A huge brass tray, gift from the society in India at the time of its 50th anniversary, adds a convincing adornment to the reception room.

Of great interest to the earth scientist and mineral collector as well as the metallurgist is the unique mineral garden displayed beneath the geodesic dome. It is a saucer shaped garden with very large and not so large specimens of the world's most important sources of metal, distributed among quartz pebbles instead of soil. On display are specimens of hematite, magnetite, jasper and taconite from Michigan and Minnesota, where Ohio's iron ore is obtained; bauxite, the aluminum ore from Arkansas; nickel, copper, manganese, zinc, lead and silver from all over the world; and Ohio's own metallurgical limestone used for flux in blast furnaces. A total of 65 specimens are displayed.

They were donated to Metals Park by the mining companies which extract these materials from the earth. The mineral garden is the focal point along with the geodesic dome, for it clearly illustrates the need and source of the materials which have made modern technological advances possible.

The American Society for Metals is a non-profit, educational society dedicated to the advancement of technical knowledge. Members represent 50 different countries. America's metal working industry is the largest in the world. It employs nearly half the work force. In sales it was a $182 billion industry in 1970 with 105,000 plants and 35 million employees.

To fulfill its educational and informational purpose, the society publishes educational journals describing the current advances in the industry and conducts expositions and institutes. Engineers and other scientists from all over the world attend workshops at the headquarters, and mail courses are offered by outstanding scientists from institutions such as the Ohio State University, University of Wisconsin, Bethlehem Steel, and the National Bureau of Standards. These courses provide basic information on a variety of subjects related to the metals industry and are open to interested individuals at any level of training, including high school students.

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Another major thrust is to publish technical books, many of them valuable additions to a high school library. Career development, with an expanding program of guidance services, is offered to any high school teacher, science club or service club at no charge. The society makes a great variety of kits, books, films and awards programs available to the educational community.

The American Society for Metals is oriented toward the extraction of ores and development of materials for man's use. Much is to be gained in giving students an awareness of what these non-renewable resources are, where they come from, what uses are related to environmental issues, and what new technologies are being developed to meet environmental problems. The ores in the mineral park are beautiful specimens to study, large enough to see their properties and to stimulate further study. The magnitude of the geodesic dome is great enough to convince the most indifferent observer that metals are dramatic, versatile, strong and beautiful.

The beech maple forest offers a sharp contrast of a living ecosystem with the non-living materials so important in man's world. It seems quite likely that a hike through the near-virgin woodland might balance the visual experience of the geodesic dome in a student's sense of values.

Classes from elementary schools are invited to park, view the geodesic dome, study the ores in the mineral garden and hike in the forest. High school classes in earth science, chemistry or physics may arrange for a talk by a society staff member tailored to the special interest of the class. Contact: Manager, Public Relations, American Society for Metals, Metals Park, Ohio 44073, Phone: (216) 338-5151.

Geodesic Dome

NORTH CENTRAL BRANCH OHIO AGRICULTURAL RESEARCH AND DEVELOPMENT CENTER

Location: On Wahl Road, five miles northwest of Castalia, Erie County, Ohio. Follow SR 6 to Wahl Road.

The North Central Branch of the Ohio Agricultural Research and Development Center has made and continues to make a considerable contribution to the solution to drainage problems, field surface preparation, crop varieties and wildlife research for the farmers in the Black Swamp (old lake bed) area of northern Ohio.

One of the most fascinating and least understood environments is the cattail marsh. The dense cattail growth and mucky substrate usually make an unwelcome environment for the casual visitor. However, at the North Central Branch interested people can observe much of the cattail marsh while remaining on the grass-covered dikes. The dikes provide good access and are wide enough to allow a fairly large group to gather.

Marshes are widely recognized by scientists as valuable for water retention and water table stabilization. They are also important in maintaining wildlife habitats for preservation and research. This is an excellent site for a study of resource management and land use planning.

The North Central Branch, Ohio Agricultural Research and Development Center, is a 350-acre farm that includes 130 acres of marshland and two 10-acre swamp-forest woodlots. The land was donated to the center for research purposes by an Owens-Illinois glass company land owner in 1950. Experimentation on drainage systems has resulted in the effective use of low dikes and tile drainage around small field units representing different kinds of surfaces. The water collected in the system drains into a well-like structure for measurement. A large number of these units have been put into operation.

The station personnel also conduct research on the results of different kinds of tillage. They experiment with the traditional surface preparations for crops—plowing, disk harrowing, and drilling—and compare production, soil and water loss with a minimum tillage which involves very little preparation. The use of mulch, which is a covering with manure, straw, or mixture of materials to prevent rapid evaporation and provide soil nutrients, is studied also.

Irrigation methods, measurement of the way water moves through the soil, and agronomic research on soybean varieties, sugar beets, grain sorghum, and dry beans help to provide answers to the problems farmers in the area encounter. The red-winged blackbird intrusion conceivably could be controlled by substituting one or more of these crops for the usual corn crop, favored by the farmer as well as the blackbirds. Blackbird research has been conducted for five years, utilizing banding, decoy trapping, and oral sterilant measures together with the study of migration patterns, thus giving insights into means of controlling the much maligned bird which has nested in this habitat since recorded time.

In constructing the earthen dikes that divide the marshland into segments, researchers found that water is supplied to the segments by artesian wells and Sandusky Bay. The motive for building the dikes was to make the marsh more suitable for waterfowl hunting and muskrat production. Water control structures located between the segments allowed water levels to be adjusted so that optimum habitat conditions could be maintained. However, since the earliest experimentation, the water control structures have deteriorated. Today, water levels fluctuate with artesian well flow and, in some segments, with Sandusky Bay.

The bedrock underlying the North Central Branch is Silurian-age rock belonging to the Monroe group. The rock layers have a high lime-magnesium content. They dip regionally to the southeast. Owing to the deposits of glacial drift and lake clays these rocks are not exposed for examination. (Wilbur Stout, *Dolomites and Limestones of Western Ohio*, Geological Survey Bulletin 42, 1941.) Small deposits of peat representing an accumulation of marsh vegetation are present.

The porous structure of the bedrock allows water passage and artesian wells have been developed. Water flows from the wells at a constant temperature of 51°F. The well water is very hard, with approximately 1700 to 2000 parts per million hardness and a pH of approximately 7.0.

The vegetation at the North Central Branch is influenced by several factors that make it interesting for study. Numerous plants have been introduced by farming operations and others have undoubtedly been carried in by water currents crossing the Great Lakes. In addition, varying wetness in the segments produces successional stages from old-field type plants to cattails.

The cattail-marsh segments:
In the cattail marshes the most abundant plant is, of course, the cattails themselves. At the North Central Branch, cattails provide food and building material for a large muskrat population. They also provide nesting sites for several species of birds including red-winged blackbirds, long-billed marsh wrens, yellowthroats, ducks, rails, and gallinules. In addition, the cattails, primarily the heads and roots, house an invertebrate population that serves as a food source for several species of birds and fish. A large variety of aquatic organisms can be collected from cattail roots that have been pulled from the water.

Several plants with snowy flowers grow mixed in with the cattails. Examples of these are swamp

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Lake Erie Marsh

rose-mallow, Indian hemp, and loosestrife or false dragonhead. Occasionally in small areas, swamp rose-mallow or loosestrife become the predominant plants and in mid to late summer these produce a showy spectacle of flowers.

Other interesting marsh plants that may be observed near the cattails include wild iris, flowering rush, sneezeweed, and several species of buttercups. Along the dikes other plants such as the evening primrose, great gaura, heal all, evening lychnis, or sow thistles can be found.

The old-field segment:

This segment is drier than the others and the vegetation is mostly old-field succession type plants. Roughleaf and silky dogwoods grow in thick stands in the segment. Other plants include teasel, Queen Anne's lace, goldenrod, and asters.

The loosestrife segment:

The loosestrife becomes a showy spectacle in mid to late summer when the purple loosestrife flowers cover about three of the four acres in the segment. The remaining one acre contains old-field plants such as asters, goldenrod, and grasses.

The swamp-forest woodlots:

Two 10-acre swamp-forest woodlots are present, one wetter than the other. The wetter woods are subject to periodic flooding after heavy rains or when Sandusky Bay has a high water level. Because of this, little ground cover is present. (However, in spite of the flooding, moneywort can often be found in fairly large patches.) The predominant trees are silver maple and ash. Several large, dead elms can also be seen in this woods. These elms were apparently, at one time, part of a climax forest but were killed by disease.

The dryer woods has a substrate that is wet to moist and the predominant trees are hackberry and shagbark hickory. A few oaks are growing in the dryer end. The ground cover of this woods includes spring beauties and Dutchman's breeches but some spots are too wet to support ground cover.

The most abundant mid-sized mammal in the marsh is the muskrat. Muskrat houses dot the cattail marsh and their dens are often dug into the dikes. Muskrats can frequently be seen during the daytime feeding on the dikes or swimming near cattails. Other mammals present in the marsh area or on the dikes include meadow voles, white-footed mice, shrews, rabbits, woodchucks, raccoons, opossums, skunks, fox squirrels, [illegible], and possibly mink.

The red-winged blackbird is the principal nesting bird in the marsh and in surrounding hay fields. Other nesting birds include yellow warblers, robins, brown thrashers, catbirds, killdeers, pheasants, mourning doves, woodcocks, and woodpeckers. During spring and fall migrations a large number of ducks, warblers, and other migratory birds can be seen.

Reptiles present at the North Central Branch include six kinds of snakes and two species of turtles. The eastern garter snake is the most commonly seen snake, followed by the northern water snake. The interesting fox snake, whose range is restricted to south Ontario, eastern Michigan and north central Ohio, is found at the North Central Branch. Other snakes include the all-black melanastic garter snakes, queen snakes, and northern brown (DeKay's) snakes. No poisonous snakes have been observed at the North Central Branch, but this does not completely rule out their presence.

The two turtles present are the snapping and midland painted turtles. The painted turtles can frequently be observed sunning on logs during warm weather. Both species deposit eggs into small holes they dig into the dikes. During spring and early summer, it is not uncommon to find a turtle in the process of preparing a nest.

Amphibians present include five species of frogs, one toad, and one salamander. Spring and summer evenings are filled with a loud chorus of frog voices — leopard frogs, green frogs, bull frogs, Blanchard's cricket frogs, western chorus frogs, and perhaps others. American toads are occasionally seen and these produce a distinctive chorus during spring. Only one salamander has been observed at the North Central Branch and this was the small-mouthed salamander. This salamander is in the mole salamander group whose members spend much of their lives underground. For this reason, it is difficult to find one.

Several species of fish are present in the water areas of the marsh. Carp can frequently be observed spawning in the shallow water and sometimes among the cattails when water extends into the cattail growth. Bluegill sunfish, green sunfish, and bullheads are often taken by fishermen, and occasionally a large-mouthed bass is caught.

No interpretive personnel or public facilities are available at the North Central Branch. However, each spring and summer, a college student or wildlife biologist resides at the North Central Branch and does research with red-winged blackbirds. This person is usually well qualified and willing to lead short tours as long as the tours do not conflict with the research.

Limited restroom facilities located in the dairy barn may be used, and if desired, the dikes or other grassy areas are suitable locations for enjoying a sack lunch. Contact: Farm Manager, North Central Branch, OARDC, Route 7, Vickery, Ohio 43464, Phone: (419) 684-5037.

SHAKER LAKES REGIONAL NATURE CENTER

Location: The Nature Center is principally in Cleveland, Cleveland Heights, and Shaker Heights; a very strategic location. It is easily accessible because it is in an area where all three of these municipalities meet. Several types of public transportation can be used to reach this center.

The land was originally the site of the former North Union Shaker colony, and has been public park land since 1895. The nature center has been in existence since 1966. It is part of the park system of the City of Cleveland, but is now leased from Cleveland by the City of Shaker Heights.

The area is made up of six layers of shales and sandstone and glacier deposits representing the bedrock of the Cleveland area.

There are a variety of trees and flowers with a large mammal and bird population. Although surrounded by suburban areas the mammal and bird population is not limited. It serves as a concentrated migration route for birds.

The Nature Center is a non-profit corporation supported by private contributions, with a unique exception — the staff is partially supported by the three local school systems. This means that the programs are available to students from very diverse social and economic backgrounds. It is a community organization whose broad function is community support.

Recognition of the quality of the programs has resulted in the designation of the nature center as a National Environmental Education Landmark by the United States.

Programs are available to all, arranged by appointment, but geared toward class-size groups rather than individuals. A small fee is charged to schools who do not support the center. Week-end and summer programs also exist. Contact: Director, Shaker Lakes Regional Nature Center, Shaker Heights, Ohio, 2600 South Park Boulevard, Cleveland, Ohio 44120, Phone: (216) 321-5935.

Ubiquitous Spring Beauty (Claytonia sp.)

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ADDITIONAL CUYAHOGA-GRAND RIVER WATERSHED SITES

Auto-Aviation Museum, 10825 East Boulevard, University Circle (Cleveland) 44113, Phone: (216) 721-5722, Ext. 69.

Adjacent to the Western Reserve Historical Society Museum in the cultural heart of the city, this museum displays old cars and planes on an old time street. It emphasizes the importance of Cleveland as an early automobile manufacturing center. Fee covered in charge at the Western Reserve Historical Museum.

Beaumont Scout Reservation, on SR 45 at Rock Creek in Ashtabula County, Contact: Director of Camping, Greater Cleveland Council of Boy Scouts of America, Woodland and East 22nd Street, Cleveland 44115, Phone: (216) 861-6060.

This extensive Boy Scout reservation with the Grand River flowing through it and a wide variety of habitats offers an excellent site for water quality and land use study.

Brunsman Fruit Farm, Rt. 307, 1 mile west of Rt. 534, Geneva 44041, Phone: (216) 466-1348.

Harvest time beginning after Labor Day to the middle of November is apple, pear, and grape picking time on a do-it-yourself basis on weekdays and Sunday afternoons. A study in resource management.

The Burton Historical Museum and Pioneer Village, Burton 44021, Phone: (216) 834-4852.

A tour to this charming Western Reserve village and museum provides an appreciation and understanding of the northeastern Ohio heritage. A sugar camp demonstration takes place on Sundays in March.

Camp Hi, on Abbott Road, north of SR 82, and west of Huron, contact: Director, Camp Hi, 3599 Randolph Road, Cleveland Heights, 44121, Phone: (216) 381-5259.

An exceptionally fine waterfront on the upper portion of the Cuyahoga River is available for studying various aspects of the river.

Cedar Point, on a Lake Erie peninsula north of Sandusky, Erie County, Phone: (216) 522-1280.

The mile-long beach, concessions, Frontier Trail and craft displays are fun and educational. Water studies and lake level problems can be a challenge. Land use for recreation, water quality.

Cleveland Health Museum, 8911 Euclid Avenue, Cleveland, Phone: (216) 231-5010.

A modern building now houses the oldest health education facility in the United States. Displays are colorful, spectacular and informative. Admission: children 25¢, adults 50¢.

Cleveland Museum of Art, 11150 East Boulevard, Cleveland, 44106, Phone: (216) 421-7300.

This world famous museum offers an opportunity to see how man interprets the world in which he lives. Free films and special classes available. Guided tours are arranged upon request.

Goodyear Tire & Rubber Company, 1144 East Market Street, Akron 44316, Phone (216) 794-2121.

A tour of the plant to watch a tire constructed, step by step, and a visit to the museum which shows the discovery of vulcanization provide an opportunity to understand the contribution of this industry to American life.

The Great Lakes Historical Society Museum, 480 Main Street, Vermilion 44089, Phone: (216) 967-3467.

This lake front museum has special collections of Great Lakes models, paintings, photographs, marine artifacts and relics. Special group rates for guided tours.

Holden Arboretum, Lake and Geauga Counties, Sperry Road off Route 6, Kirtland 44094, Phone: (216) 946-4400.

Natural beech maple forests, spectacular rock formations, birds and extensive horticultural gardens make this site an educational and delightful experience. Land use planning and resource management.

Kelley's Island, in Lake Erie, 10 miles north of Sandusky.

This small island has a significant social and economic history. A study of the limestone and grape industries, the communications problems and the outstanding natural features make a challenging ecology lesson.

Lorain Fossil Fuel Generating Station, Contact: Public Relations Department, Ohio Edison Company, 47 North Main Street, Akron 44308, Phone: (216) 762-9661.

Environmental concerns: energy, air and water quality, resource management.

Milan Historical Museum, Village of Milan, 10 Edison Drive, Milan 44846, Phone: (419) 499-4201.

This is the birthplace of Thomas A. Edison; it is a Moravian settlement, an Indian area and canal town. There are three museums operated for the collection and display of local historical and artistic materials. Environmental concern: preservation of the American heritage.

Mill Creek Park, Youngstown Township Park District, 816 Glenwood Avenue, Youngstown 44502, Phone: (216) 744-4171.

A scenic oasis in an industrialized valley, this park is outstanding in geologic features, vegetation and history in spite of its proximity to urban air and water quality problems.

River and land use studies are feasible.

Mosquito Creek Reservoir Wildlife Area, at SR 46 and 305, north of Warren, Contact: Manager, Rt. 1, Lockwood 44435.

Although this extensive acreage around an impounded stream lacks picturesque topography, it is an excellent site for studying resource management and land use.

Railroads of America, on Rt. 8, five miles north of Akron, North Hampton 45349, Phone: (216) 923-2507.

An excellent opportunity to study the railroad era through the world's largest collection of operating model trains. Admission: children 60¢, adults 85¢.

Republic Steel Company, Public Relations Representative, P.O. Box 6778, Cleveland 44101, Phone: (216) 574-7686.

A plant tour might be taken along with the Goodtime II Cruise down the Cuyahoga River. Children can see the process of conserving ore into steel and all the technology needed to complete this process.

Resthaven Wildlife Area, west of SR 269 and Castalia, P.O. Box 155, Castalia 44824, Phone: (419) 684-5049.

A large ponded and remnant prairie area reclaimed for wildlife habitats, this site has been stripmined for marl. Water quality and resource management.

Timmon's Dairy Farm, on US 422, seven miles southeast of Chagrin Falls, Auburn-Bainbridge Road, Phone: (216) 543-9771.

A specialized dairy farm where students can see milking and the feeding of cows, milk treatment and refrigeration, silos and machinery. Arrange well in advance. Resource management.

U.S. Coast Guard Station, Whiskey Island, New West Pier, Cleveland 44119, Phone: (216) 522-4412.

Guardsmen instruct in boats, beach apparatus, weather signals, warnings for boats, radio beacon and fog control. Reservations in writing two weeks in advance.

Vermilion River Study, at Mill Hollow-Bacon Woods Park, Contact: Director, Lorain County Metropolitan Park District, 126 Second Street, Elyria 44035, Phone: (216) 322-7800.

One of the Lorain County Metropolitan Parks, this site is located in the river valley giving access to riverine studies. A nature center, historic museum, duck pond and self guided nature trails are additional features. Environmental concern: water quality and land use planning.

Western Reserve Historical Society, 10825 East Boulevard, Cleveland 44106, Phone: (216) 721-5722.

Indian exhibits, log cabin and period rooms, ship models, the Bingham doll house and the Tinkerbelle sloop are intriguing to children. Admission 35¢ for children, 75¢ for adults.

Youngstown Sheet and Tube Company, Contact: Guided Tours Director, Box 900, Youngstown 44501, Phone: (216) 758-6411.

Arrangements may be made for taking students 15 years or older on a bus tour to see an open hearth furnace, hot strip mill and seamless tube mill. Concerns center around the process, resource management, air and water quality and uses of energy.

Maumee
Watershed Region

BACKGROUND INFORMATION

Biophysical Environment:
Northwestern Ohio, embracing the Maumee River Watershed, the Portage and the Sandusky, lies wholly within glaciated till plains. The streams meander sluggishly over the almost featureless plains, eventually draining into Lake Erie. The area covers approximately eight thousand square miles, with most of its topography monotonously flat, broken only by the streams, their cut banks, and flood plains which are frequently lined with vegetation.

Bedrock in the region consists of sedimentary strata and includes limestone, dolomite, shale and sandstone. The Monroe formation of Silurian age, the oldest exposed rocks in northwestern Ohio, are relatively pure dolomite (magnesium-limestone) and serve as a valuable source of underground water as well as for agricultural lime. On either flank of a geologic feature known as the Cincinnati Arch, younger rocks underlie the glacial deposits. (See geologic map.) The arch is significant only because the internal disturbance which caused it resulted in the slight tilting of the strata (shown in cross section). The long axis of the arch extends northward beyond Ohio into Canada. The Columbus limestone of Devonian age overlies the dolomites in a narrow belt that extends across the western part of Lucas and Wood counties and on through Henry, Defiance and Paulding counties beyond the margins of the state. Still younger, highly fossiliferous Devonian beds follow the same arc. Except in quarries and occasional stream or road cuts, all the strata are obscured by thick deposits of glacial material. Still younger Mississippian sandstones and shales are found in the extreme northwest corner in Williams and Fulton counties.

The entire area is covered with glacial drift ranging from a thin veneer to a thickness of 135 feet. During the final wasting back of the last glacier, meltwater from the ice was ponded between the ice front and the glacial materials previously deposited. The meltwater lakes remained for sufficient time to allow deposition of fine materials, chiefly clay and fine sand. Glacial end moraines, marking the furthest extent of glacial advance, occur as low, hummocky ridges. Beach ridges representing windblown and shoreline sand deposits of several stages of the ice impoundment mark the edges of the glacial lakes.

Most of northwestern Ohio was originally covered by great hardwood forests. Beech, maple, oak and hickory covered the better drained areas, with a swamp forest of elm, ash and soft maple on the lower lands. There were prairie openings which interrupted the extensive forest.

Because the region was settled late in Ohio history due to the nature of the swampy terrain, the value of timber had already been well established. With the completion of the Miami and Erie Canal, wood products from the region were in high demand. Agricultural use of the land eventually replaced the forests. Woodlots, vegetation along the streams, and the 3000 acre Maumee State Forest constitute a high percentage of the natural vegetation areas which remain. Goll Woods in Fulton County, comprising 322 acres, is an unusually good example of nearly virgin forest in Ohio's Black Swamp, the name frequently used to designate the former lake bed and its vegetation.

Socio-economic Development:
No record of prehistoric Indian cultures in the Maumee Region has been found. Presumably it was easier for early man to walk around the swamps than to live in them! Later, Wyandot Indians, a part of the Hurons who were driven out of eastern Canada and across Lake Huron by the Iroquois conquests, drifted southward and remained in the Sandusky and Maumee valleys. Although they were few in number they were known to be brave fighters and inclined to be less cruel in their treatment of prisoners than other tribes. The most renowned leader was Tarhe (the Crane), the acknowledged head of all the tribes who received the Indians' copy of the Treaty of Greenville in 1795. Although over seventy years old during the War of 1812, Tarhe led his warriors under William Henry Harrison's command. Harrison characterized Tarhe as the noblest of all Indians.

Reclamation of land was necessary before settlement could become extensive and roads could be built. Surveys of the land using a mile square road system were made and thus established the population pattern for this part of Ohio. By this time railroads, too, had been constructed. German farmers who sought homes in the midwest in the 1850's were among the first settlers, attracted to the low cost lands. To them the arduous task of reclaiming the land so it could be tilled was not too great. Most of them settled in Wood, Henry, Putnam and Paulding counties where productive land could be acquired for the effort of reclamation and careful farming practices. Carl Varvel stated in an *Ohio Journal of Science* article (Vol. 32, No. 6, Nov. 1932), "Nine out of ten neat farmsteads in the four counties named above are operated by descendants of the first German farmers." In contrast, people from Poland often occupied the prairie openings found on the sandy tracts west of Toledo.

Cooperative drainage projects, encouraged and assisted by the government, and the fairly good, light-colored, moderately productive soils surrounding the old lake plain of dark-colored, very productive soils, provide the physical basis for prosperous agriculture in the region. Corn is the major crop and corn feeding the principal source of cash income. However, many specialties are also produced: sugar beets in the Maumee Valley, truck and vegetable farm products (especially tomatoes) for canning, dairy products, soybeans, onions in the marshes at the headwaters of the Scioto, melons, sweet corn and pumpkins. Yields tend to be high, giving good reason for the region to be regarded as a uniformly prosperous agricultural area. It ranks first in percentage of land devoted to farming. The relatively sparse population and the productivity of most of its soil have resulted in a high income per farmer. Suburban and urban development in Lucas and Wood counties is responsible for the only appreciable decrease in cropland in recent years.

Northwestern Ohio is not one of the major areas of industrialization. It is primarily a one-city area in industrial development, the city being Toledo.

Toledo, eight miles from Maumee Bay, occupies both sides of the shallow river valley. It has been a lakeport since the building of the canals which opened up the interior to lake commerce. An important railroad center as well, it ranks among the top eight in the nation. Toledo has had no great mineral industries at hand; neither has it attracted steel-makers. Rather its central position in an agricultural economy, its east-west transportation accessibility, and its proximity to Detroit have led, after a late start, to a steady growth.

During the early 1880's, the Maumee Valley oil and gas field discovery with its large yet temporary yields, attracted industry to the area. Libby Glass was founded in 1888, the beginning of an extensive glass industry. In 1890, as Libby-Owens, the plant shrewdly developed machines for automatically making bottles and flat glass. In 1896, on the east bank of the Maumee below Toledo, the great Ford plate-glass factory was established. More recently glass blocks for construction have been added to the list. Subsequent developments in the automobile industry have carried this glass industry into the front ranks of United States manufacturing. Willys, Chevrolet, Champion Sparkplug and Electric Autolite are other important auto-related manufacturing industries. Now that the gas field is practically exhausted, oil refining with pipelines a thousand miles long has developed to significant proportions.

Toledo is fourth among United States ports for all tonnage. It ships more bituminous coal than any other Lake Erie port, although its coal comes from mines about 300 miles distant. Toledo's exports and imports from and to Canada greatly exceed those of its sister city, Cleveland. So many visitors throng to the port to watch an enormous heavy lift crane doing the toughest loading and unloading jobs, that the city has built an observation platform where this operation and many others can be watched. From this port move manufactured products and grain as well as coal and inland foreign trade.

The city zoo, parks and museums, and the metropolitan park system are famous and give a rich cultural environment to the 383,000 people who live there.

At this end of Lake Erie is South Bass Island, with a beautiful state park, and famous Put-in-Bay. A double memorial here honors the victory of young Commander Perry, who defeated a British fleet in Lake Erie in 1813, and recognizes the long friendship between the United States and Canada. (Perry's famous words after three hours of fighting — "We have met the enemy and they are ours" — have been paraphrased for an environment-conscious population to say "We have seen the enemy and we are they.")

Perrysburg and Maumee, small cities lying so close to Toledo they seem a part of it, were settled earlier and developed faster at the outset. Perrysburg, founded in 1816 and named for the naval hero, was the county seat of Wood County until 1866. A few miles west of Maumee is the site of the Battle of Fallen Timbers, historically significant as the victorious battlefield of Mad Anthony Wayne which made possible the Treaty of Greenville in 1795. Along the river is Napoleon with its large Campbell Soup plant and adjacent tomato fields.

Upriver is Defiance, termed the western anchor for the line of small industrial cities which are growing across northern Ohio. Large, ultra-modern plants have been established which provide materials for even larger interlocking industries. For instance, "an Oldsmobile V-8 block poured at the foundry (General Motors Corporation) at 7 a.m., can be processed, shipped by truck and assembled in an Oldsmobile engine in Detroit twenty-four hours later" (Alfred J. Wright, *Economic Geography of Ohio*, 1957).

Van Wert, farther west in the Maumee watershed amidst farms of vast acreage, is primarily a food processing city with Borden's cheese plant, Continental Can and smaller plants making clothing, cigars and canned foods.

Lima, near the headwaters, with a population well over 50,000 people, is the center of five converging freight rail lines. Important manufacturing industries have taken advantage of this prime location. Feed mills, too, supply large quantities of livestock feed consumed in Ohio and states beyond. An important honey bee plant has been established because of Lima's accessibility.

Findlay, situated on the southern margin of the lake plain, lies on the Blanchard River, a tributary of the Auglaize, which in turn flows into the Maumee. Its settlement began in 1821, but growth was slow until the natural gas and oil boom after the Civil War. The oil field is known as the Trenton, a formation within the Ordovician rock series. It lies in the form of a crescent, from near Toledo southward and westward past Bowling Green, Findlay and Lima to the Indiana state line. The automobile revolution, begun during the boom period, gave a new use for the petroleum products. As happens in many oil booms, the supply dwindled, and although extraction continues, it is small compared to the needs for Ohio.

Bowling Green, situated in the Portage River Watershed, has a population over 20,000. It was founded in 1834. A State Normal School opened in 1914 which later became Bowling Green State University.

Fremont, on the Sandusky River, is famous as the site of a successful War of 1812 encounter and the home of Rutherford B. Hayes after he finished his term in the White House. His estate, Spiegel Grove, together with the library and museums, has been designated a National Historic Landmark. Fremont also is the home of a manufacturing plant making solenoid switches for automotive and other electrical products. It is a complex stamping, plating, magnetizing, winding and assembling operation. Fremont was chosen as the location for this plant largely because of its available trained and stable female labor as well as nearness to raw materials.

Upriver is Tiffin, named for Ohio's first governor. Its early settlers were from the South and from Germany. In 1850 Heidelberg College was founded, but industrial growth was not to begin until 1888 as a result of the discovery of natural gas which brought in the first of the glass manufacturers.

Man's Impact on the Environment of the Region:

In no other part of Ohio has the physical environment of a region been altered as thoroughly by man as this one. It changed from a heavily forested area with prairie openings to one used for extensive agricultural purposes. More than ninety percent of the total area was reclaimed from swamps to provide ditched, well-drained fields. Shorelines along Lake Erie and Sandusky Bay have been developed as vacation areas. Percentage of land in urban use, which includes highways, railroads, and industries, is highest in Lucas County, with 42.5 percent; least in Paulding County, with 4.4 percent. Preserved for wildlife and research are 7500 acres of marshland, shoreline and inland waterways lying between Toledo and Port Clinton, known as the Ottawa National Wildlife Refuge, Crane Creek Wildlife Experiment Station and Crane Creek State Park. A visit to these sites affords an understanding of the earlier environment.

With over 100 industrial users in metropolitan Toledo alone, and more than 2000 within 6500 square miles, an energy crisis confronts this region. Gas and oil supplies have diminished, which means there is a greater demand for electricity. Power plants now line the shores of Lake Erie from Buffalo to Detroit, with a high concentration in the Toledo area. Toledo Edison has two fossil fuel plants at the mouth of the Maumee on the east side and is constructing a nuclear plant along the shore. It is apparent that if all the power plants return their many thousands of gallons of cooling water directly to the lake there may be more widespread harm to aquatic life than at present. More research is necessary to determine the extent of damage. The use of electrostatic precipitators is now required to remove particulate matter from the air which pours from the stacks of each plant, but problems still emanate from the gases emitted. The storage of radioactive materials from nuclear fission and danger from accidents are additional specters which man must deal with. Fusion is presently being introduced as one primary source of power for the future. A promising possibility is the fuel of fission (hydrogen), which is limitless and does not produce radiation. Neither solar nor thermal energy is practical for this region, but fission may be the answer.

Water and Water-related Problems:

Following is a description of water-related environmental problems made by Dr. Jane Forsyth for the Ohio Academy of Science News:

"The geologic material present at the surface throughout most of northwest Ohio is glacial till, underlain by limestone (or dolomite) and locally covered by a thin smear of sand. The till contains so much clay that it is very 'tight,' or impermeable, thus preventing any significant amount of water from soaking down through it. In addition, the land is very flat, flatter than anywhere else in Ohio. As a result, water tends to stand for a long time on the surface of the ground, not soaking in because of the impermeability of the clay-rich till and not running off because of the flatness of the land. There are solutions to this field flooding — tile drain pipe in the ground and drainage ditches — but the extent of the very flat, clay-till-covered land is so great that no method yet devised completely solves this drainage problem.

"The presence of the water on the clayey till creates another problem by forming a sticky mud that makes a real headache for farmers and others using the land and that, as the famous Black Swamp, played a major role in limiting transportation routes of early settlers. In contrast, once the water has finally all evaporated away, the clayey ground can become almost brick-like, another farmers' headache.

"In addition to this flooding of fields, flooding also occurs along Lake Erie and in the valleys of the main streams in northwest Ohio (as in other parts of Ohio). Flooding of low-lying areas along Lake

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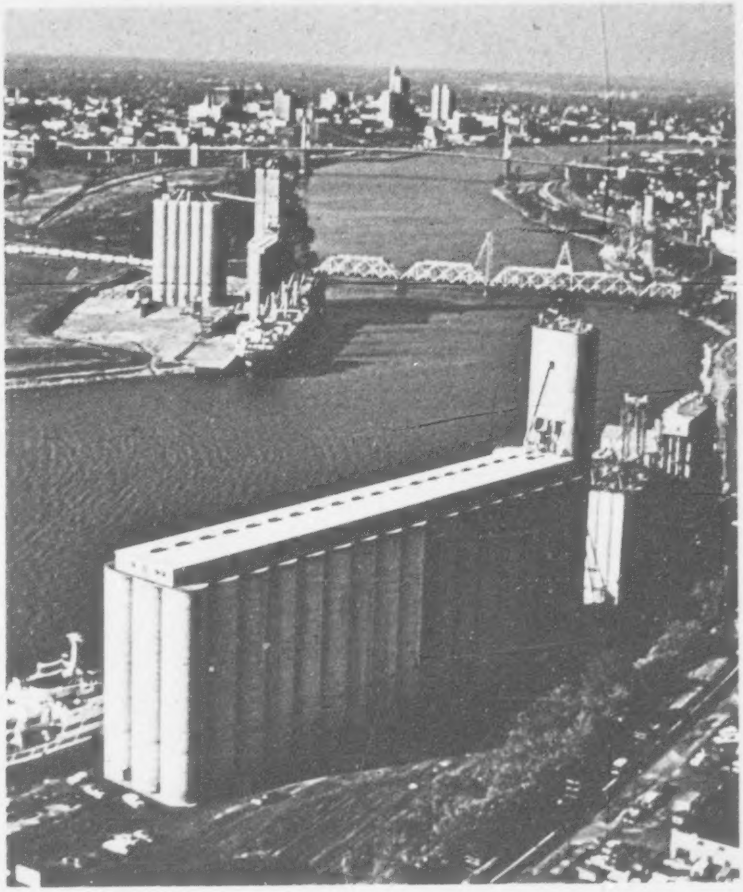
Erie, especially during northeast storms with high winds, is a serious problem. Flooding along the rivers of northwest Ohio is worse than elsewhere in the state because the gentle gradients (slopes) of these flat-land streams do not drain the flood waters away very fast, so the flooding persists for some time. Such flooding is also increased by ice jams during the winter. Ice jams can be dynamited, but the only answer to damage from flooding by the river is to keep all flood-destructible features — homes, businesses, and the like — off the flood plain.

"The impermeability of the clayey glacial till has another effect on man's use of the land. Septic tanks (small, individual home-sewage-treatment units) work only when the treated effluent can flow out from them. Where the ground is impermeable, very little such flow occurs. Even "leach beds" (a few square feet of buried man-made permeable gravel ground), which do improve the quality of the effluent, do not solve the permeability problem, for drainage is good only to the point where the leach bed ends against the clayey till. There is no easy solution to this problem. The addition of aeration units improves the quality of the effluent from the septic tank, and it helps, where possible, to tie into a municipal sewage-treatment system.

"Pollution of surface water exists in northwest Ohio, as it does throughout the state. However, except for a few large cities that draw their water from large rivers or Lake Erie, water is obtained from wells. Unfortunately, now, the first signs of contamination of ground water resources have appeared. Ground water found in the bedrock of northwestern Ohio is recharged wherever the permeable zones in the rock are exposed in creeks, lakes, or old quarries. If the water in these places is polluted (and most are, now, from incompletely treated or even untreated sewage or industrial wastes, or from an inadequately located sanitary landfill), the ground water will become polluted, too. And when this happens, the pollution persists for many years!"

The development of upground reservoirs for city water supply has come into wide use in recent years. This system makes it possible to pump water into a reservoir from the nearest stream when water is sufficiently high, yet not full of sediment, and to store it in diked surface reservoirs.



Port of Toledo

Great Blue Heron

ARCHBOLD: A COMMUNITY PROFILE

Location: In southwestern Fulton County, at the intersection of US 2 and SR 6.

Archbold exemplifies to a high degree a unified and intelligent effort to deal with a village's environmental problems. Long before most of the other communities in the area or the state had become aware of potential difficulties, the village officials and interested citizens of Archbold took the following steps to meet the needs created by growing industrialization and population:

> They devised a comprehensive plan for growth.
>
> They established zoning regulations which located new industries and new housing developments advantageously for all concerned.
>
> They increased water supply and continued to seek sources for growth and emergency.
>
> They elected to separate storm water from sanitary sewage, the only municipality in northwest Ohio to accomplish this to date (Spring 1973).
>
> They installed a modern sewage treatment plant (1961).
>
> They hired a village administrator to carry out the directives of the mayor and the village council.
>
> They formulated and executed plans to meet the school, health and recreational needs of the community.

Archbold lies on a flat plain, formerly the bed of a glacial lake, a forerunner of the present Lake Erie. Surrounded by stretches of broad fields indicating productive soils, the area was once covered with elm and ash swamp forests. Except along some of the residential streets of the village and an occasional woodlot breaking the monotony of the many-acre fields, there is little evidence of the early, lush vegetation. The land is drained by Brush Creek, a tributary of the Tiffin River which flows into the Maumee. Deep under the glacial deposits of clay and till lie Devonian beds of shale, poor producers of water.

Like most of the Black Swamp (former glacial lake beds) territory, Archbold was settled late in the Ohio story. In 1836 a Seneca County farmer walked through swamp and wilderness to reach this place, build his log cabin, and farm his half-section of land. A few years later he sold lots to have neighbors. A railroad pierced the wilderness and the resulting settlement fourteen years later encouraged more newcomers. The pioneer village of 300 was incorporated in 1866 with a Swiss harness maker its first mayor. The village has the distinction of having changed two blocks of knee deep mud into the first paved street in the Toledo—Elkhart area. The construction of a school and St. Martin's Lutheran Church were early indications of the kind of community spirit which pervades today. An electric interurban line from Toledo to Indiana, built in 1905, increased communication with neighboring towns and the thriving Toledo metropolis. In 1913, Archbold had a fire which wiped out most of its business district, but by 1925 the block was almost entirely rebuilt. Ruihley Park, named for a mayor who served 12 years, was proposed in 1922, and again reflects the community's response to basic human needs.

In contrast to Gatshall Brothers sawmill, which employed most of the village workers in 1885, there are now 22 industries in Archbold, employing 2700 of the people who live in the area. La Choy Foods, a subsidiary of Beatrice Foods, and Dinner Bell located in Archbold in the 1940's because of the rich farm land and rail transport. La Choy, earlier in Detroit, moved out during World War II to raise and process tomatoes, regarded as necessary to the war effort. But after the war, the plant re-established its Chinese food processing. Wages in the food industries were higher than the national average, a factor which drew a substantial labor force from the surrounding areas. Village officials attribute the increase in the number of plants following this pattern, in part, at least, to the quality of labor. Numbers of energetic German farm people, no longer essential to highly mechanized agricultural production, have joined the industrial labor force. A copper plating plant, Fulton Tubing, and a woodworking plant also employ a large portion of the labor force. The healthy industrial complex gives Archbold a real estate tax base of $22 million.

The food processing plants, although not the only heavy users of water, have high requirements. La Choy uses one million gallons per day; Dinner Bell, three or four million gallons per month. Deep wells provided the source until 1951, when the village officials built an upground reservoir and a water treatment plant to guarantee continuous service and quality water. The plant was expanded and a second reservoir constructed in 1961, providing a capacity for daily treatment of 2.25 million gallons a day.

The process of treatment begins with water draining by gravity into purifying basins where ferric sulphate, lime in the form of calcium oxide, and carbon are added to moving water. Flocculation is visible to the eye and causes settlement to the bottom. Carbon is fed for taste and odor and chlorine for killing bacteria. This is followed by phosphate feeding. The water then flows into large filter banks with 30 to 40 inches of coarse gravel on the bottom graded to fine sand on top. Water used to clean the sand filter periodically and the sludge material are flushed into Brush Creek. The treated water is then stored in a tank below with a capacity of 225,000 gallons, in an elevated standpipe storage tank, or pumped to customers. A new million gallon filtered water storage reservoir is to be completed September, 1973, on land west of the La Choy Food Products plant. The supply will be controlled automatically by telephone from the treatment plant.

Southwest of the village along Brush Creek is the sewage treatment plant. A tour of this facility is equally as interesting and enlightening as the water treatment plant. The food processing plants are the major dischargers of water laden with organic waste material. The industries are taxed according to the amount of water consumed and the condition of sewage fed into the system. In 1961, when the facilities were constructed, three industries, working with the village officials, helped by partially underwriting monies for construction.

At the plant, the raw sewage is pumped from the intake lines to a primary tank where, during the two hours of detention, heavy material sinks and is then pumped to the first of two digester tanks. One ton of lime a day is fed into the first mixture to remove the phosphate. Flocculation takes place and the minerals settle. In the primary digester hot air is introduced in the bottom of the tank. It rises and keeps the mass moving and the material in suspension. At the point of overflow the sludge moves into the secondary digester. This tank has a floating lid which traps the methane gas generated by the warm sludge. The gas is directed to an adjacent heat exchanger (furnace) where it is ignited and used to heat the hot air forced into the primary digester. Much of the time this source heats the whole control building as well. There is an auxiliary connection with a natural gas source which automatically provides the heat if the methane gas from the sewage is not sufficient. The digested, anaerobic sludge is drained off into tanks and delivered directly into the fields of farmers in the area. Municipal sludge is usually incinerated or carted off to landfills. But with air pollution a major problem and land for landfills scarce or expensive, the village of Archbold has pursued this course. The benefit as a fertilizer for the crops has been well demonstrated.

The water from the first (primary) tanks with the heavy material settled out passes to first one aeration tank, then to re-aeration, next, to a second aeration tank, followed by re-aeration. Water finally goes to a clarifier or sedimentation tank, is chlorinated, and stored in a lagoon on the property, and finally goes to Brush Creek. The excess sludge from this process goes into an aerobic sludge tank (where oxygen is fed in) with the same final disposition. Dissolved oxygen of three milligrams per liter is maintained. A water testing laboratory where samples of every step of the processes are taken five times a day provides the basis for the monthly reports required by the health department. Tests are made for dissolved oxygen, oxygen demand, pH, copper, cyanide, nitrates, phosphates, chlorine, settlement solids, suspended, dissolved, and total solids.

Archbold's council chambers, city clerk and treasurer's office, police force, fire department and village administrator's office are housed in the village building near the center of town. A recent renovation provided for an attractive court and council rooms adorned with a gigantic aerial photograph showing clearly all parts of the village. The mayor holds court once a week and executes his position in addition to running a business of his own. Considerable responsibility falls upon the shoulders of the young administrator, who was previously the superintendent of utilities. The village officials work with industrial leaders to solve the mutual problems which arise. One looming not too distantly is a water shortage. One possible way to avoid a problem is to join with the Maumee Conservancy District and the Department of Natural Resources on a regional basis to construct one large dam retaining 3.3 billion gallons of water. Some in the community thought this not practical—that underground water supplies should be tapped. Rather than risking a stalemate, La Choy initiated a $28,000 drilling program in 1972 to determine the adequacy of that resource, only to find that the water was unusable. Plans are unresolved as of Spring, 1973, but with Archbold's history of joint problem solving, the village can be confident of reaching a reasonable and acceptable decision.

Support for schools, churches and recreation has gone hand in hand with financial and governmental institutions. In a period when most small rural communities lose their young people to city opportunities, an estimated 75 percent of Archbold's young people go to college, then return to the community, according to local school officials. Others attend the Four County Vocational School, or the Northwest Technical College which adjoins it, then take up positions of responsibility within the industrial complex or elsewhere in the community. This fact in itself is a tribute to the efforts of Archbold's planners. Contact: Mr. Nolan Tuckerman, Village Administrator, Archbold, Ohio 43502, Phone (419) 445-4025.

BRYAN CITY SCHOOLS OUTDOOR LABORATORY

Location: South of the city limits on West High Street extension (County Road D), east of Lick Creek, Williams County.

This site is suggested as a study in resource management and land use planning. It is a good example of preservation of a natural environment for studies in biology and earth science as well as a means to create awareness and understanding of environmental values in a total school population.

Situated on a flat, open area, the outdoor laboratory is bounded on three sides by a ravine, and on the fourth, the north side, by railroad tracks.

Three soil types are found at the site — Crosby Group, Brookston Group, and Spinks Group. The Crosby Group consists of Digby sandy loam with zero to three percent slopes and is slightly eroded. Including poorly drained soil on the level land, it has a moderately deep rooting zone, moderately slow permeability, medium moisture supplying capacity, moderate productivity potential, fair capacity for the storage and release of minerals, and a moderate wetness hazard. Much leaf mulch is being supplied to this section.

The Brookston Group contains Millgrove sandy loam and Millgrove loam soil with zero to two percent slopes and no erosion. It includes dark colored, moderately textured, nonacid, naturally poorly drained soil on nearly level land. It has a deep rooting zone, moderate permeability, very high moisture supplying capacity and a high productivity potential. These soils have a very high capacity for the storage and release of minerals and a moderate wetness hazard. Due to the wetness hazard, walnut and butternut were planted here in one section.

Oshtemo loamy sand with two to six percent slopes and slightly acid soil characterizes the Spinks Group. The soil is light colored, sandy textured, and moderately well drained. It has a deep rooting zone, rapid permeability, low moisture supplying capacity and a low productivity potential. This soil has a very low capacity for the storage and release of minerals, has a severe drought hazard, and is subject to wind erosion. A windbreak of multiflora rose, pine, and Lombardy poplar has been planted on the north side to help control this possible wind erosion. The other sides of the area are already bounded by natural wooded areas as previously mentioned.

The original soil analysis of the area was performed by the Soil Conservation Service by request. Soil testing by students can help confirm their analysis.

Extensive plantings have been made by the biology classes each fall and spring, concentrating upon a wide variety of species for teaching purposes. The deciduous trees planted have been tulip, sweetgum, wild cherry, ginkgo, paw paw, beech, Lombardy poplar, pin oak, buckeye, Norway maple, sugar maple, ironwood, hornbeam, hickory, linden or basswood, walnut, and butternut.

Among the coniferous trees, white pine, Austrian pine, yew, arbor vitae, blue spruce, Norway spruce, fir, red cedar or juniper, and hemlock have been planted.

Shrubs and vines include bittersweet, autumn olive, chokeberry, and multiflora rose.

The taking of wildflowers is discouraged. Plantings from a wildflower nursery in Minnesota were purchased to replicate naturally occurring species. These included white baneberry, wood anemone, columbine, jack-in-the-pulpit, wild ginger, turtlehead, Dutchman's breeches, gentian, hepatica, cardinal flower, Solomon's seal, May apple, trillium, bloodroot, carrion flower, foamflower, white violet, and spring beauty.

Bird houses and a squirrel-hollowed log nest home have been erected. Grass nature trails, outlined by wood shavings obtained from the industrial arts department of the high school, are being built. Elementary students are contributing to the project by planting sunflower and other seeds to attract wildlife.

The idea for an outdoor laboratory was first conceived by Ann Zumfelde of Bryan as a student at Defiance College. With assistance from the biology department of Bryan High School, she made it the subject of her winter term project at the college. It was hoped that a location could be found nearer the school, but this was not possible.

Shortly after graduating from Defiance College, Ann Zumfelde died of a brain tumor. Following her untimely death, a memorial fund was established for development of the laboratory. Most of the trees and some equipment were purchased with monies from this fund.

The site was a farm purchased by the city of Bryan for landfill operations, across the road from a similar site which had been filled to its capacity. However, the Ohio Department of Health closed the second operation before much dumping could be accomplished because of drainage into nearby Lick Creek. Now only the city leaf collection is dumped here and these leaves, when decomposed, furnish excellent mulch. Students carry many of these leaves in plastic bags to the outdoor laboratory area for mulching around old as well as newly planted trees. Students have been encouraged to make compost piles at their own home yards and to compare the results to expensive peat moss.

Although utilized primarily by Bryan school classes, the laboratory may be visited by teachers or committees of students interested in establishing their own outdoor laboratory facilities. In a few years, when the plantings (mostly seedlings) are larger,

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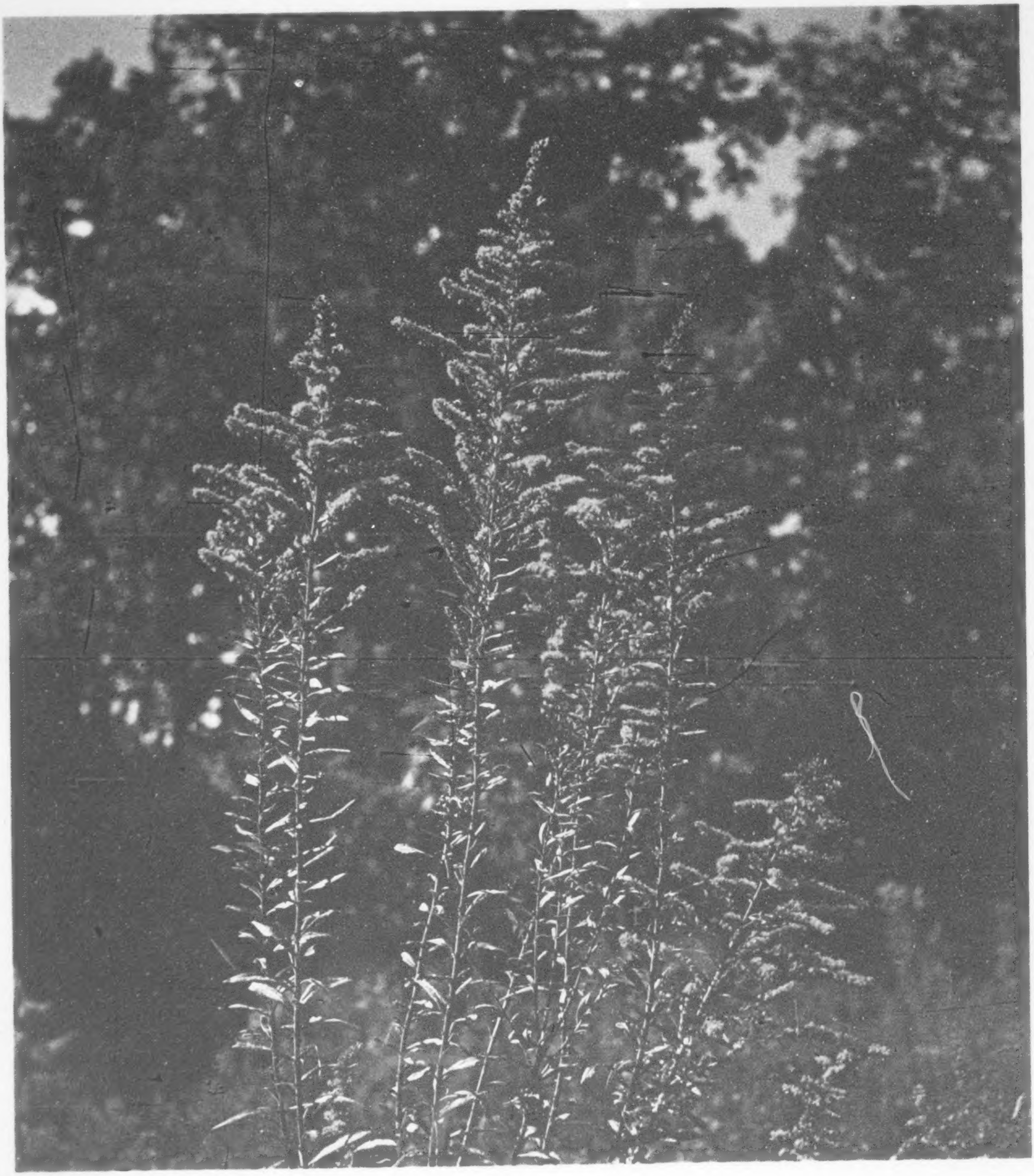
other groups may wish to visit the site. No prior permission for visitation is required.

Eventually it is hoped that a nature center can be constructed on another part of the farm adjacent to the outdoor laboratory.

There are no shelter houses, sanitary facilities, nor water available. A parking area, suitable for about four school buses, is available along County Road D near Lick Creek. Contact: Biology Department, Bryan High School, Bryan, Ohio 43506, Phone: 636-4536.



Goldenrod (Solidago sp.)

CROSBY PARK AND GARDENS

Location: 5403 Elmer Drive, Toledo, off Reynolds Road, one block south of US 20.

Although the Crosby Park and Gardens are still in the initial development, even the expansive green spaces and existing diversity of gardens and micro-communities can be exciting learning sites. Crosby Park and Gardens offer two important experiences in an informal outdoor learning setting: The opportunity for teachers and youngsters to gain an awareness of purely natural systems as they might be found in a more rustic situation, as well as a close look at managed systems, such as the flower and children's gardens, associated with people-affected environments. Both of these experiences hold the potential for demonstrating how environmental problems can occur and the conservation techniques that can be used to solve them.

A few huge apple trees behind the children's garden, an old barn, and a 20-acre plot, formerly a rich soybean field, all were parts of the Hawkins farm in the past. In 1920, George P. Crosby, a Toledo real estate broker, purchased approximately 20 acres of land adjacent to the Hawkins farm where he built a modest wooden office for himself and a handsome stable for his daughter's horses. When Crosby died in 1965, this retreat was willed to the City of Toledo for the Gardens.

With the financial backing of the city Forestry and Parks Departments plans were made to develop a park and gardens. Within the past few years the initial phases of the plans have been implemented, including the construction of a conference building, the development of several flower gardens, and the purchase of 20 acres of the Hawkins farm. Another parcel of the Hawkins farm adjacent to the park was sold to the Toledo Board of Education for Hawkins Elementary School, which will share a creative playground area with the gardens. The Board of Education has also become involved in planning and supporting other park programs where possible.

Evidences of the glacial lake plains which predominate in the entire Maumee River Valley are quite apparent in the essentially flat terrain of the park. It is broken only by a gentle slope leading down to the narrow creek which slowly meanders through the width of the park. Large red oak trees shading the wild flower garden and conference building near the park entrance, stand as the sole reminders of great hardwood forests which once covered this upland valley.

A walk through the wildflower garden, with its abundant rhododendron and azalea, and a glimpse of the park office, housed in Crosby's restored retreat house and stables, immediately set the tone of a rustic and informal environment. The garden path is grassed and railroad ties form the borders to the large flower beds. In the office building, the original overhead beamwork of the stables, the latched door handles, and even the old wagon wheel chandelier have been well preserved.

From the expanse of the patio windows in the new conference addition to the stables, a whole spectrum of learning sites is visible. A small ravine has been carved out to become a pond ecosystem housing water lilies and other vegetation, small fish, and microscopic life. In the large planter adjacent to the conference building a variety of flora well adapted to sunny conditions are on display. At the children's garden, the soil is freshly plowed in the Spring and youngsters may plant their first vegetable plot. Behind the children's garden lies the ecology study area. This meadow-like ecosystem will remain unmanaged to follow its natural succession.

The remainder of the park and gardens is laced with beds of beautiful tulips, gladiolas, hyacinth, and paper birch trees.

With just a little imagination, the visitor can see a neat red brick path planned to extend throughout the park and gardens. It will pass by the outdoor classroom amphitheater that is to be carved into the slope leading down to the creek. Behind it is the site for the greenhouse. In addition, several more landscaped terraces are planned to accommodate a special rock garden and a fragrance garden.

Each of the diverse micro-environments at the gardens offers youngsters a unique learning experience in understanding the dynamics of natural ecosystems. The relationship between the eroded banks of the creek and the sediment in the creek, for example, is immediately apparent. Youth can gain invaluable insights into techniques used to beautify landscapes, bank soil erosion, develop creative play areas, and make a vegetable garden.

Teachers will be invited to learn about the park and gardens in workshops before they bring out their classes. Then they can assist their own students in learning about the park. An experienced horticulturist will also be available.

One stop that is a must before leaving the Crosby Gardens is the Toledo Environmental Clearing House found just in front of the park offices. It offers a wealth of environmental resource information on Toledo, the state, and the national scene.

In the Spring of 1974, the park program is expected to be sufficiently developed to accommodate student groups. For the first few years only, groups are limited to upper elementary classes of no more than 35 children. Contact: Crosby Park and Gardens Horticulturist, Division of Forestry, 5403 Elmer Drive, Toledo, Ohio (419) 536-1031.

FINDLAY RESERVOIR AND WATER TREATMENT PLANT

Location: The reservoir is southeast of Findlay off SR 568 on county road 205. The treatment plant is at 110 North Blanchard Street just north of the bridge over Blanchard River.

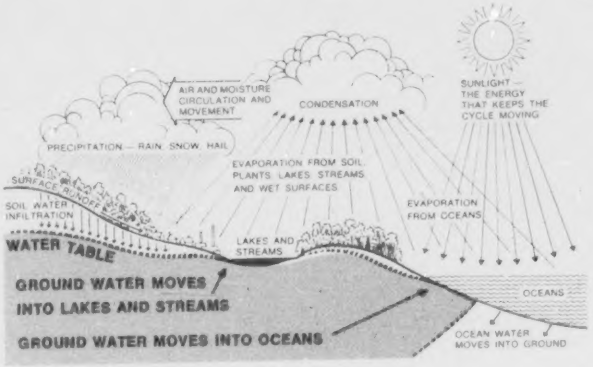
This study describes a variety of sources of water for the city of Findlay, which has a population of 36,200, and the method of treatment, which includes the chemistry and physics of producing high quality water.

An understanding of geologic features and processes is fundamental for comprehension of water problems in any place, but in northwest Ohio this is particularly true. Geologists explain the basic principles of water movement by means of an hydrologic cycle. Great amounts of water in the oceans evaporate and rise as gases into the atmosphere. As the moist air rises it becomes cooled. If a tiny fragment of salt or particulate matter is available as a nucleus, the moist air particles condense as they cool to form clouds. Unequal heating of the earth's surface by the sun sets up movements of air or winds which carry the moisture-laden air over the land. When the clouds become cool enough or other favorable conditions prevail, precipitation in the form of rain, snow, sleet, or hail occurs and falls to the earth's surface. Here it may strike a rock surface, a steep slope, blacktop street, or packed-down soil and run off into ditches, streams, rivers, lakes and ultimately back to the oceans. Or if the surface has a vegetation cover or an open soil, the rain infiltrates into the soil and penetrates to a water table level below the surface which constitutes a great reservoir for use by plants and animals. This ground water moves slowly by gravity toward the watershed drainage basin and ultimately to the sea. Evaporation takes place where any land surface is exposed to air, and together with transpiration of plants, creates a continuous cycle of moist air ascending and descending. When water moves through a porous rock layer such as sandstone or limestone and encounters a shale layer through which water cannot move, the drainage follows the shale layer to the surface and erupts or seeps to form springs.

Such is the situation in northwest Ohio, in Seneca, Sandusky and Erie counties. Underlain by layers of limestone dipping a little to the north, rainwater drains into surface cracks, joints and sinkholes to the ground water level which produces a network of channels in the limestone. When a channel reaches an impenetrable shale layer it emerges at the surface to form springs, or in the case of the Blue Hole at Castalia, a deep well of water.

THE HYDROLOGICAL CYCLE

The circulation of water is continuous and irregular, rather than cyclic. All phases operate simultaneously, but at different places, and at different times.


AIR AND MOISTURE CIRCULATION AND MOVEMENT
CONDENSATION
SUNLIGHT — THE ENERGY THAT KEEPS THE CYCLE MOVING
PRECIPITATION — RAIN, SNOW, HAIL
EVAPORATION FROM SOIL, PLANTS, LAKES, STREAMS AND WET SURFACES
SURFACE RUNOFF
SOIL WATER INFILTRATION
EVAPORATION FROM OCEANS
WATER TABLE
LAKES AND STREAMS
GROUND WATER MOVES INTO LAKES AND STREAMS
OCEANS
GROUND WATER MOVES INTO OCEANS
OCEAN WATER MOVES INTO GROUND

The history of water in Findlay includes the use of such a spring as its source of water. Its first water system, installed in 1889, consisted of a reservoir fed by the Blanchard River through filters of gravel and charcoal. Tests showed this to be quite inefficient since the filtered water sometimes contained more bacteria than the river. In addition, the public water supply was badly polluted by waste from numerous oil wells in the watershed following the discovery of an oil field in the area. Instead of drilling a well, the Findlay officials investigated the possibility of tapping into a big spring or waterhole on Limestone Ridge about nine miles southeast of the city. The water was tested and found to be 100% pure. The rights were leased from the owner, a 24-inch pipe was installed to carry the water to the city, and a pump was added to aid in times of heavy demand. The spring provided 1,025,000 gallons of water per day; its supply was constant and it filled the needs of the city until 1931. According to one writer, the spring water gave Findlay a new slogan: "The city of pure water and low taxes." The cold spring water from the ridge, now used with water from the reservoir, results in water of a lower temperature after it passes through the filtering process.

The present impressive treatment and storage plant was built in 1930-31. Its capacity was four million gallons daily and it used lime-soda ash filters. The first reservoir was completed in 1949 with a capacity of 1.4 billion gallons. The second, built in 1969, has a capacity of a little over 3.5 billion gallons. Together the reservoirs cover a square mile. These are upground reservoirs, so-called because they are surrounded by dikes on the surface of the ground. Water is pumped into the reservoirs from the Blanchard River, but not at flood stage when full of sediment. It flows to the plant by gravitation. Average daily raw water coming into the plant at the

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present time (1973) is seven and a half million gallons.

The treatment plant is a clean and efficient operation to see. Activated carbon is added to the raw water as it leaves the reservoir as a treatment for taste and odor. At the plant the raw water is chlorinated for bacterial control, and starts its treatment at the bottom of the softening unit where a solution of calcium hydroxide, sodium hydroxide and aluminum sulphate is added. The water rises upward through a sludge blanket or cloudy section of the tank caused by suspended particles already precipitated. The water runs from that tank into a carbonation basin, where carbon dioxide is forced through it. Sodium fluoride is added on the way to settling tanks where most of the suspended calcium and magnesium salts settle out. The water then goes through rapid sand filters, is again chlorinated and conducted to an underground storage unit. The average hardness of the raw water is about 262 parts per million; treated water is near 80 parts per million. The water supply of Findlay has been fluorinated since 1967. In February, 1973, the Ohio Environmental Protection Agency gave the city's water quality and treatment facilities the highest ratings attainable.

A trip to the reservoirs is a treat. The large one, enclosed by three and a half miles of dike, appears to be a sizeable lake, with sail boats and motor boats in a marina, people fishing on all sides, and a multitude of ducks during migration times.

Findlay is the home of some large industries which are heavy consumers of water. Largest is the Cooper Tire Company, requiring 226 million gallons a year; GW Sugar Plant, 25 million; Eastman Kodak, approximately 33 million; Ashland Refining, over 100 million gallons per year; and RCA, 138 million.

The full tour is recommended for junior and senior high school students. Small groups of six to 10 are desirable for laboratory studies and analyses which students can learn to do in the water laboratory situated at the first reservoir. For laboratory studies, contact Jack Wilfong, Department of Biology, Findlay College, Findlay, Ohio 45840. Phone (419) 422-8313. For field trip, contact Director of Utilities, Municipal Building, Findlay, Ohio 45840. Phone (419) 423-6711.

Clouds over Ohio

GOLL WOODS

Location: Goll Woods is located approximately two miles north of US 2 equidistant between Stryker and Archbold in Fulton County.

It is suggested for study because it is a remnant of northwest Ohio as early settlers found it. The site is also an example of the preservation of a special natural community which is valuable for research and for knowledge and appreciation of a natural environment.

The topography of the area is flat, being a lake plain underlain by Mississippian sandstone. It is a part of the old Black Swamp named for its blackish waters. The Black Swamp was the bottom of an ancestral part of Lake Erie. Formerly, the glaciers created a dam of ice preventing the natural flow of the stream to the north which reunited in a larger lake than the present Lake Erie. When the ice of the glaciers melted, clay and silt deposits prevented proper drainage. Since that time, most of the land has been drained by using tile, channelization, and ditching. The swamps of Goll Woods have thus far escaped this fate.

Goll Woods is one of the last fragments of the beautiful swamp forests of primeval virgin timber. The giant oaks here are truly awe inspiring — towering in height and extensive in girth. Many are over 100 feet tall. Many require three or four students with arms outstretched to circle their trunks. To gain the correct perspective, it is interesting to form this same circle away from the tree and then even more amazing to form it again back in the classroom.

In addition to the oaks, there are slightly higher sections forming climax beech maple forests with their characteristic lack of ground cover due to the extensive shade. Other trees in abundance are ironwood, hickory, ash, tulip, cottonwood, and basswood or linden; also pawpaw, sycamore, hop hornbeam or muscle wood, box elder, dogwood, redbud, aspen and slippery elm. Many American elms were destroyed by the Dutch elm disease and a few barkless trunks remain. The official state tree, the buckeye, has been planted near one of the parking lots, and one of its close relatives, the horse chestnut, is also present in limited numbers.

Students interested in wild flowers find Goll Woods a paradise. Over one hundred species are here in abundance. Now that it has become a public property, it is hoped that teachers remind their students of the importance of not picking these flowers nor saving them for collections. As our population increases, such activities must be discontinued. We must study species in their living condition on field trips.

In addition to the virgin timber, students can explore several large acreages of planted trees, particularly Austrian pine which will eventually furnish fine coniferous forests to contrast with the deciduous ones. The forests offer a study in ecological succession from one form to the other.

Many of the tree species are labeled with large attractive signs. A teacher may wish to send members of his field trip committee ahead of the group with a jacket or some type of cloth to cover the signs until the group identifies the specimen.

One section of the park has the Tiffin River with its aquatic species flowing through it. A few wood duck pairs nest here. This spot gives access for river ecology studies.

In the swamp pools, tadpoles of the wood frog and toad can be found along with larvae of many insects including mosquitoes. During the mosquito season, it is strongly recommended that students bring along insect repellent. Red-backed salamanders are the most prevalent species of salamander, but park rules prohibit students from leaving the trails to turn over logs to find them.

Deer are often seen on early morning field trips as well as in late afternoon when they wander out into the open areas of the newly planted tree plantations. Raccoons, opossum, grey and red fox, and skunk have also been observed. Among smaller mammals, chipmunk, deer or white-footed mice, shrew, the nocturnal flying squirrel, grey and red squirrel are common.

Birds are in great abundance. The tall trees often make identification of many smaller species difficult for the untrained student, but other species below the high canopy can be readily identified. Common birds include wood thrush, many species of woodpeckers, wood pewee, tufted titmouse, cardinal, Baltimore oriole, indigo bunting, blue jay, cowbird, chickadee, nuthatch, scarlet tanager, crow, and brown creeper. Among the birds of prey, great horned owl, barred owl, red tail hawk, and Cooper's hawk have all been observed nesting here. As the pine plantations increase in size, birds as well as other animals peculiar to this environment can be expected to fill this niche.

The Goll family, for whom the park is named, came to the United States from France in 1836. Mr. and Mrs. Peter Goll, Sr., purchased 80 acres for $1.25 per acre from the Federal Land Office in Lima in 1836. They increased this acreage in the following years until it totaled over 600.

The Golls had great reverence for those enormous trees, and Peter Goll, Sr., determined to preserve a part of it for posterity. So great was his love for these giants, that he had an attractive wooden fence constructed around a large part of it.

The woods remained in the Goll family for four generations with the love and pride of ownership

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passing from parents to children. It is indeed fortunate for all of us that members of each generation chose to follow the family tradition of preserving the woodland.

Finally, in 1966, Mrs. Charles Goll Louys sold the woods to the Ohio Department of Natural Resources, asking that the woods be preserved for posterity with the verbal stipulation that no large trees were to be cut without consulting the Goll descendents. Unfortunately, however, the largest bur oak was felled in 1968. Broad swaths have been cut through the woods, also, to make paths for visitors to enjoy. But essentially the property remains as a memorial to the early owners.

The future master plan for the Goll Woods property is to increase the present 322-acre area to a total of 1500 acres. The Tiffin River basin is to be impounded by the building of dikes to provide a large fishing lake under a Soil Conservation Service project. The area would include picnic facilities, Adirondack camping, concession house, and additional parking. At present there are no water, shelter house, or picnic tables. Many of these plans, however, may well be challenged by those wishing to maintain the natural condition of the woods and stream. Contact: Ranger, Maumee State Forest, Rt. 1, Swanton, Ohio 43558, Phone: (419) 822-3052.

Measuring a bur oak at Goll Woods

LABINO GLASS SHOP

Location: On the west side of the intersection of SR 65 and Kellogg Road, east of Grand Rapids, Wood County.

The Toledo area has long been recognized in Ohio and elsewhere as the glass capital of the world. Development of this industry was due to several factors, one of which was the availability of natural gas which lured a Massachusetts glass manufacturer to this cheap fuel in the early 1880's. Local sandstone became an important but never dominant factor in Toledo glass making. The expansion of glass and fiber glass industries coincided with the development of the automobile industry which required glass products, particularly plate glass. Other specialties, including the manufacture of glass blocks for construction, were to follow.

With quantities of glass emanating from commercial sources, it is small wonder that the ancient art of glass craftsmanship was resurrected in Toledo. This study is suggested as a means of examining the creation of the art form, the natural materials from which it is derived, and the processing of the material, for an understanding and appreciation of one of man's useful and beautiful tools.

In 1965 Dominick Labino retired from a long and successful career in research and development of glass with one of the large Toledo glass manufacturers and established a laboratory and glass blowing workshop at his country home. With his accumulated knowledge of glass technology and his love for creative art in glass, it was a natural development for him to start blowing glass. In the few years since, Mr. Labino has created many pieces, a representative number of which are on display at his shop.

Forty different museums have some of his work in their permanent collections and he has received innumerable awards in exhibitions. Cincinnati Museum of Art, Cleveland, Columbus, Massillon, Ohio University, College of St. Joseph, Butler Institute at Youngstown, Milan Historical Museum, Capital University, Defiance College, the Toledo Museum of Art and the Toledo Federation of Art Societies Permanent Loan Collection comprise the places of exhibits in Ohio. Collections may be viewed in Corning, New York; Lancashire, England; Washington, D. C., and many other cities in the United States.

Glass has been made by hand by individual craftsmen since 1500 B.C. in Egypt and continued as a craft until a century ago. But modern technology made it possible to mass produce uniform and inexpensive glassware with quality controlled by industrial designers and engineers. Therefore, glass making as an art by individuals almost completely died out.

A dramatic breakthrough was made by the Toledo Museum of Art in 1962, when it announced its first workshop in glass blowing. It was quite appropriate that the industrial glass capital of the world and a museum already committed to glass by virtue of its world-famous collection of ancient glass, European and American glass, would begin a renaissance in the art of glass blowing. Dominick Labino contributed his special skill to this workshop and to the ones following. Four subsequent workshops were held in his own studio. Attendance was limited to experienced artists and craftsmen, mainly university instructors who came from all over the country and went back to impart their skill to others.

In 1966 the museum announced the first national glass competition. High standards were set and the Toledo Glass National became a greatly respected exhibition. A magnificent new gallery has been constructed by the Toledo Museum of Art for display of glass objects. A striking creation by Mr. Labino, a large glass mural at the entrance, entices visitors to explore the 4000 year history of glass.

A tour of the Labino glass shop begins with an explanation of the chemistry of glass by the co-pilot of this venture, Mrs. Labino. Early basic glass compositions consisted of one of three systems: sand-soda-lime, sand-potash-lime, and sand-lead-barium-potash. The Egyptians, because they found a natural natron (an impure form of soda ash), used it on the first combination. Near the seacoast, seaweed ash was used as a source of sodium. Where wood was plentiful, woodash was a natural and abundant by-product used in the second combination. Chinese glass analyses seem to indicate that glass was composed of the sand-lead-barium-alkali type. (Dominick Labino, *Visual Art in Glass*, Brown Co., 1968).

Ancient glasses did not differ too greatly in composition from those presently used. Modern technologies have contributed to special glasses. The "singing" crystal glass so cherished by a modern hostess is the result of high lead content in the composition and of greater accuracy in the selection of raw materials, which in turn is the result of advances in chemical analysis.

"Color development in glass has maintained a status quo, or in some cases, has lost ground over the centuries. Color effects are the direct result of chemical changes in the glass composition during the fusing period, the forming period or annealing period" (Labino, *op. cit.*)

At least 35 elements are used alone or in combination to create color effects in glass. The oxide chemical form is the one used most often. Copper, iron, nickel, cobalt, manganese, chromium, gold chloride, silver nitrate, and cadmium sulphide are a few of the colorants which are added to produce the spectacular results on display in the glass shop.

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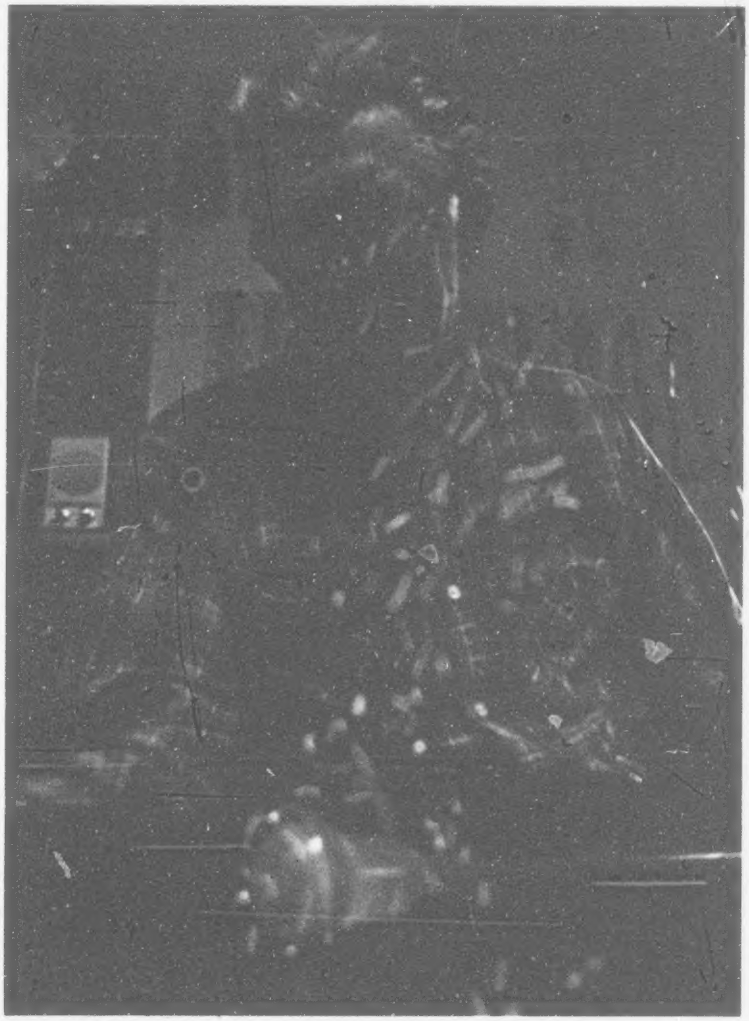
Reflection, absorption and transmission of light are actually responsible for the exciting color effects.

The tour through the shop affords an opportunity to see the master craftsman at work. First a "gather" of molten glass is heated in a gas fired furnace. Mr. Labino has designed and constructed four of these with the heat source at the top. The gather is at the end of a blow pipe which makes it possible to inflate the piece after it is first shaped by turning it in a cup-like wooden bowl. These bowls are fashioned from fruitwood, preferably cherry or apple. The object is then worked with other wooden tools, a "punty" rod is attached to the base, and the blowpipe removed. The artist then shapes the neck and the mouth of the vase, snaps off the punty, and the object is placed in the annealing oven where it gradually cools to room temperature.

Though Mr. Labino follows the basic steps described above, most of his pieces are not simple. There are many other steps in between, and his object may be returned to the furnace many times. In addition to his blown pieces, he makes solid sculptural forms which are executed entirely in the molten state.

The demonstration, the knowledge of the raw materials used to produce calculated physical and chemical reactions, and the display of the many works of art created by two unusual people is an experience of a lifetime.

The Labinos will arrange tours for classes in the fifth grade and up. Size of groups is limited to 30. Arrangements must be made several months in advance. Contact: Mrs. Dominick Labino, Grand Rapids, Ohio 43522, Phone: (419) 832-2105.



Dominick Labino creating a work of art

LITTLE AUGLAIZE WATERSHED CHANNELIZATION PROJECT

Location: on the Little Auglaize River and Middle Creek in the vicinity of, and south of, Oakwood and Melrose, Paulding County.

The purpose of this study is to examine a massive channelization program initiated by the Maumee Conservancy District and the Soil Conservation Service. The material presented upon this highly controversial subject is designed to help teachers and students study the area and arrive at their own conclusions, in so far as it is possible, regarding the merits of the program. The study deals with land use planning, resource management and water quality.

The Little Auglaize Watershed under consideration, which includes its tributary, Middle Creek, lies in the eastern part of Paulding County. The area is underlain with Silurian age dolomites in the Monroe group, a fact which influences the soils to some degree. Of greater importance is its location in the old lakebed region, a part of Ohio commonly called the Black Swamp. The soils consist of laminated or layered silt and clay deposited in a temporary lake dammed to the north by retreating ice. The soil association in the vicinity of the study is classified as Paulding-Roselms, named for two of the towns within the soil region. The Paulding series soils are moderately dark colored, poorly drained, developed in the very fine-textured lake clays. They are gley soils formed from layers of blue clay showing partial oxidation. The amount of clay ranges from 60 percent to more than 80 percent. The sand content rarely exceeds 10 percent. The parent material (see soil profile in *Reading Ohio's Landscape*, "Soils of Ohio") contains from 15 to 25 percent carbonates. The water-laid materials are four to 15 feet thick. Gravels or boulders, common on most parts of glaciated Ohio, are almost nonexistent. The Roselms series are similar in clay and carbonate content but are light colored and occupy the bottomlands of the Paulding soil area. These contain less humus, showing formation under different drainage conditions. Both soils occur on nearly level relief; water seeps through them very slowly. Surface ditches as well as field tile are needed for drainage. The productivity of the Paulding soils varies greatly with the management used. They are moderately productive where good tilth or surface preparation is maintained and adequate drainage provided. The Roselms soils are lower in productivity.

Most of the area has been cleared and cultivated, although there are occasional woodlots scattered throughout. The native forests consisted chiefly of pin, bur and swamp white oak, with elm, ash and hickory in the association. One small prairie grassland north of Oakwood is indicated as being present in the early 1800's.

Land values are variable, primarily reflecting the influence of the effectiveness in drainage. The better, slightly higher level Paulding soils sell for approximately $800 an acre; the middle level $650; and the lower Roselms acreages about $400. The principal crops are soybeans and corn. The growing season is long enough for field crops to mature. The winters are often cold, with temperatures of 20 degrees below zero and considerable snowfall. Summers bring oppressive, hot, humid periods. Moderate amounts of rainfall, averaging 34.12 inches yearly, are fairly well distributed, although flooding is not unusual in spring and droughts in late summer or fall. (Soil Survey, *Paulding County, Ohio*, USDA Soil Conservation Service in cooperation with the Ohio Department of Natural Resources and the Ohio Agricultural Experimental Station, 1960).

Following the passage of Public Law 566, establishing small watershed programs designed to meet the drainage, flood and drought situations in Ohio, the Maumee Conservancy District organized to institute a massive channelization program in VanWert, Paulding, Putnam and Mercer counties. The Little Auglaize River project was approved in 1967, and a ten-mile segment completed in 1969. The stream below Oakwood was shorn of its vegetation on both sides, deepened, widened and relieved of some of its meandering oxbows. It was seeded promptly with grass and at present has the appearance of a well manicured lawn. Federal funds paid for the flood control aspects of the project, land rights and easements for maintenance were obtained, and farmers whose properties adjoin were assessed for drainage benefits.

A ten-mile segment of Middle Creek has been completed also (Summer, 1972), and another 10-mile segment is in the process of channelization (May, 1973). Woody plants such as autumn olive, gray dogwood, and numerous other species have been planted on the banks, along with grass. The recent channelizing program is limited largely to one side of the stream, permitting the other side to remain in a fairly natural condition. Riprap, taken from the bed of the stream in the deepening process, is used on the out curves to prevent erosion. In addition to the project planting along the banks and easement, farmers are encouraged to plant trees in small areas which are not tillable.

The stream carries a heavy load of sediment particularly after a heavy storm. Wildlife shelter along the banks is limited to grass, where it has had time to grow, and the water is practically devoid of fish. Pre-date and post-date surveys by the Division of Wildlife, Findlay office, indicate that there has been a great decline in speciation. Twenty-nine species were present in the Little Auglaize River prior to channelization; one, two or three species, usually minnows, are found in the stream now (1973). While this river has not been famous for its sport fishing since the building of the power dam at Defiance in 1915, there were some deep pools near the mouth of the river that offered good fishing.

Other wildlife surveys have been conducted to determine populations of birds, reptiles, small mammals and deer in the vicinity of the channelized streams. Studies could not be made prior to the project and a number of yearly surveys are necessary to make significant conclusions. Observations indicate there are more than 70 species of birds, some deer and small mammals present.

Legitimate questions which should be raised regarding this program are: How many acres have been added to increase crop production? In considering the total community, is there enough benefit from deeper drainage ditches and flood run-off to balance the changed ecology of the region? Will the removal of vegetation along even one side of the channel add to dust storm soil erosion across the broad fields? How many miles of channelization can a community, a county, a state, a country tolerate before wildlife populations diminish to an alarming degree? Were adequate studies made before the program was instituted to make satisfactory conclusions?

Drainage in the Black Swamp area has been essential from the outset for crop production. Improvements in ditching and tile draining have been a constant concern to the farmer and those agencies which serve him. Northwestern Ohio food production potential has been developed to a high degree. To what extent it is valuable to the total environment to continue experimentation with normal water conditions is a still unanswered question.

Perhaps, from a geologic viewpoint, it might be asked how long the stream will remain in a channelized pattern. Geologic forces are forever at work and may eradicate man's efforts in a period of time too short to warrant the program.

In a cost analysis, it may well be recognized that funds are largely tax-structure derived. Would channelization programs continue if the adjacent land owners, or others deriving flood benefits, had to meet the total cost?

Recognizing that food production is essential to living and that agriculture is a major part of the economy, are we as a society doing enough to support it? Is it important to consider reduced wildlife populations in light of agricultural benefits? Another very important question: are we participating in planning processes when the opportunity arises?

These and other issues may be raised by students destined to be the decision makers of the not-too-far future.

For help in locating study areas and parking facilities as well as interpretation of the project from the agricultural viewpoint contact: District Conservationist, Soil Conservation Service, 315 North Walnut Street, Paulding, 45879, Phone: (419) 399-4771.

Willing to assist in assessing the project from other aspects is: Clyde Burt, Box 26, Melrose, 45861, Phone: (419) 594-2213.

A farmer who has participated in the program, both before and after channelization, and is willing to be of assistance is: Laurel Carnahan, Route 2, Oakwood, 45873, Phone (419) 594-2890.

Another agency which can be consulted is: Division of Wildlife District Office, Findlay, Ohio 45840, Phone: (419) 422-6757.

OAK OPENINGS

Location: Oak Openings is a 130 square mile area situated mostly in Lucas County, but extending into Fulton and Henry counties. It is approximately 25 miles long and five miles wide, beginning near Napoleon and stretching northeastward to a few miles west of Toledo, near Sylvania, Ohio.

The purpose of the study is to outline areas suitable for study, education and recreation and to delineate some of the proposals concerning the area as to their environmental impact as well as their social, economic and cultural value. These projects include the new Oak Openings Community, the proposal by Swanton to obtain their public water supply in the area landfill siting as well as those for parks and natural area acquisition.

The history of the area is one of geology, for it was formed as a result of the Wisconsin glacier 60,000 years ago. The sands of the area are the former beaches of glacial Lake Warren which was about 100 feet higher than Lake Erie is today. As the glacier receded, the waters lowered leaving behind the sands which had been carried there from Lake Huron shores.

Early settlers were attracted to the land because it was clear and drier than the nearby Black Swamp and lake marshes. It was believed by many that either fires set by the Indians or naturally occurring prairie fires kept the area clear. Yet it did not lend itself to farming and E. L. Moseley (1924) noted it was characterized by poor crops, rundown buildings, abandoned farms. Today, the low swampy areas are largely drained and urban dwellers are moving into the oak "barrens" to build suburban estates and homes in areas close to Toledo. Other areas still show signs of sub-standard dwellings and low standards of living.

The level of the Openings is between 650 to 690 feet elevation. It is a sand area underlain by a relatively impermeable glacial till. The sand lies on this in undulating ridges from five to 30 feet deep. The water table is high due to poor subsurface drainage, and it lies atop the till. This results in low wet prairies between the ridges and a dune situation on top of them. There are many soil types but all are fine soils ranging from clay, sandy loam and fine sands to muck and peat deposits. The bedrock is dolomite.

Drainage is poor even with tile drainage. It is estimated the life of field tile in the area is one fourth that in most of Ohio due to the fine soils. There is a scarcity of natural streams; most of them go around the deep sand areas. But the ditches which were begun in the 1800's have provided a stream habitat in some areas.

From the standpoint of vegetation, the wet prairies and railroad right-of-ways are the least disturbed of Oak Openings' habitats. Neither of these has been plowed and therefore, they reflect the most stable habitat. The sand hills are covered with oaks and grasses with the exception of the only inland moving sand-dunes in Ohio which are preserved in Oak Openings Metropolitan Park. Moseley stated that the area was destitute of trees when first settled and that it had no natural drainage and was covered with water throughout the year. Today aspen, sumac, willows, maple and dogwoods as well as the oaks are found. Probably the commonest species of grass is Kentucky bluegrass, but there are stands of big and little bluestem as well as reed grass in small stands. Huckleberries and blueberries are still abundant but the well-known cranberry bogs of the past have disappeared. Orchids are found in prairie areas and sundews can be found in suitable habitats; both the intermediate and roundleaved sundew are here. Lupine, gentians, club mosses, St. John's wort, birdsfoot violets, lilies, ferns and many plants rare for Ohio are found here. Some of the rarest are the sedges and rushes.

Birds of the Oak Openings include yellowthroats, short-billed marsh wrens, alder flycatchers, American bitterns, Henslow's and Bachman's sparrows, yellow breasted chat, mallards, king and Virginia rails, marsh hawks, yellow warbler, red-winged blackbirds, swamp and vesper sparrows, Kentucky warbler, blue-winged and golden-winged warbler and others. Game birds include quail and pheasant as well as the ducks and woodcock and snipe.

The area was once the home of the Massasauga rattlesnake, but none have been found in recent years, exterminated, no doubt, through man's efforts. Blue racers, fox snakes, hognose and garter snakes, red backed salamanders, wood and tree frogs, American and Fowler's toads, Blandings and painted turtles are found here, as is the box turtle.

It has been reported that the muskellunge was a possible prairie breeder and the redfin pickerel inhabits Oak Openings streams. Also found there are several species of shiners and darters, chubs, suckers and large mouth bass. White footed mice, red fox, fox and red squirrels, least weasel, while-tail deer, cottontail rabbits, meadow moles, woodchucks, striped skunk, opossum, eastern chipmunk and raccoons inhabit the Openings.

Moseley and others have pointed out that while the land can be used for farming, it must be heavily fertilized for success. At one time, land in the area sold for $5 to $10 per acre. Recently, one plot had an asking price of $4000 per acre. This is due to urban encroachment and subdividing of some of the area. Much of the land is wet, however, and sells for much less, some around $650 per acre. The new Oak Openings Community was proposed for some of the substandard areas as a rural renewal project. Its purpose would be to provide for residents a total community with improved housing, educational and medical facilities and job opportunities.

The wetter areas have a great value for recreation and preservation of natural areas. In fact, there are many, including the local planners, who believe its greatest value could be that of a green belt for the Toledo metropolitan area. In this regard, some areas have been set aside including Oak Openings Secor Metropolitan Parks (which is partially within the Oak Openings belt) and Maumee State Forest. Two other areas are under purchase, Schwamberger Preserve and Irwin Prairie, both of which are to be donated to the Ohio Natural Areas System. The Toledo Area Boy Scout Miakonda Reservation and Sylvania's Olander Park are also in Oak Openings. The Toledo Zoo has plans for an outdoor animal breeding farm in the area. All of these together could form a focal point for recreation in northwestern Ohio.

The hydrology of the area is the controlling factor. Moseley pointed out that the differences in flora within the Oak Openings were due to the differences in drainage. Flooding in the area is not usually due to creek overflowing but to excessive rainfalls and soil conditions. Because of this, conservationists recommend limited construction in the area. The new community plans show several man-made lakes and there is some question as to the effect of so many such lakes on the water table and subsequently on the plant communities whose existence is dependent on specific water conditions. Heavy residential and industrial building in the area may increase the drainage problems because of increased and more rapid runoff. The contemplated drilling of wells for public water supply should also be studied more thoroughly.

Irwin Prairie and Schwamberger Preserve were purchased for the purpose of preserving their wet prairie, wet meadow, swamp forest habitats for the benefit of future generations and for study purpose. The effects of large withdrawals of water should be examined, not only because of the effects on these natural areas but also in relation to the general effects of a lowering water table in a sand dune area with the underlying impermeable layers. It is quite possible that lowering the water table could destroy the very attributes that urbanites have moved to Oak Openings to enjoy.

It should be noted that Oak Openings contains one sanitary landfill which is believed to be leaching into the ground water supply. Studies by the Soil Conservation Service have been made on a number of recommended sites in the Oak Openings. They have not approved them.

There are no alternative solutions to the lowering of the water table, largely because there is insufficient knowledge of what the effects of this might be and, therefore, there is little information with which to hold off development. However, good land use laws, both state and local, could protect what could be a useful green belt. Purchase of additional lands for open space could be undertaken. While there is some land being set aside, it is insufficient to protect the area or even to preserve substantial portions of it.

The areas within Oak Openings which are public are Oak Openings and Secor Metro Parks which are open from 8 a.m. to dusk. Naturalist services are available. There are trails. A nature center is located at Secor Park and camping is permitted. An overnight facility is available at Oak Openings Park. For information contact: Toledo Metropolitan Park District, 911 Madison Avenue, Toledo, Ohio 43624, Phone: (419) 248-5911.

Some areas of Maumee State Forest are within the Oak Openings and are open during the daylight hours. For specific information, contact. Ohio Dept. of Natural Resources, Division of Forestry, Columbus, Ohio. There are trails but no other facilities.

Schwamberger Preserve and Irwin Prairie are presently under the management of the Ohio Chapter of Nature Conservancy. Leaders for trips into these areas as well as into Maumee State Forest may be obtained through the Toledo Naturalists Association. There are no facilities and no trails at either Schwamberger Preserve or Irwin Prairie. Contact: Toledo Naturalists Association, 3831 Homewood Avenue, Toledo, Ohio 43612, Phone: (419) 473-7012.

PORT OF TOLEDO AND THE PORT AUTHORITY

Location: on the Maumee River and Maumee Bay.

The purpose of study is to examine the ecology of the area, determining the effects of the economy on the natural functions of the Maumee Bay area.

Toledo is a young seaport situated in the middle of the Great Lakes, America's fourth seacoast. The port lies in the industrial and agricultural heartland of the United States, within several hours of the nation's midwest cities. The opening of the St. Lawrence Seaway in 1959 created a new avenue between America's midwest cities and world markets. In the years since the Seaway's opening, Toledo has become known as the most aggressive port on the Great Lakes.

Work is now under way on a new port facility in Maumee Bay. It will greatly increase the port's capability to handle both bulk and general cargo, according to the port's publicity.

There is a large and diverse general cargo. Major commodities are construction equipment, machinery, chemicals, lumber, foodstuffs, steel and other metal products. Toledo is a container consolidation port and handles 50,000 automobiles per year, both import and export. The Port of Toledo is the home of the Foreign Zone serving the Great Lakes area. Grains from midwestern farmlands and coal and iron ore make Toledo's port one of the largest in the world for the trans-shipment of these products.

The Port Authority was created by an act of the Ohio Legislature in June of 1955. It is set up as a quasi-governmental body with broad powers. It is supported by a tax and may also issue bonds, exercise the right of eminent domain, purchase, lease and operate dock terminals and publicize the port and its facilities. Several years ago, 3,500 acres of the land under the Maumee Bay were given to the port. The waters are still under the control of the State of Ohio. The Corps of Engineers, Detroit District, empowered by the Rivers and Harbors Act of Congress, maintains the channel to the depth of the St. Lawrence Seaway. Dredging to private docking facilities must be maintained through private funding.

The channel is nearly 25 miles long, seven miles in the river and the remainder in Maumee Bay and Lake Erie. Since Toledo is not naturally a deep water port, access must be maintained by dredging. A present controversy rises from the plan of the Corps to dispose of the polluted dredging spoil in a diked area for the eventual use of the port as Facility No. 3. The land base is owned by the port, but it is also one of the remaining known fish spawning areas in the bay.

The requirement of impact statements and the opening up of projects to citizen inspection have brought out the fact that practically nothing is known of the effects of the growth of the economy on the life in the bay, except for the obvious changes. The Bureau of Commercial Fisheries is the only U. S. federal agency conducting basic research related to fish and aquatic life resources of the Great Lakes, and its Lake Erie office has been discontinued.

The geologic story of the Toledo area is considered to have begun 400 million years ago with the accumulation of a thick deposit of limy mud on the bottom of an ocean. This deposit was compressed into the limestone and dolomite rock layers which underlie the western end of Lake Erie and because of their different hardness cause the varying depths of Lake Erie. An ice age followed during which the characteristic silt and clay of the Maumee Basin were deposited in the ancient glacial lake. The final result was a very flat landscape, and a river with a very gentle gradient. Glacial moraines established the lines of stream flow as they now exist.

The bay and its estuary are the product of the river which flows into it. The shoreline is low and flat and swampy. The material underlying it, both on shore and offshore, is clay, which is easily eroded. The Maumee is responsible for 25% of Lake Erie's silt load, 15% of the BOD (biochemical oxygen demand) load and 15% of the phosphorus load. This contribution has been the subject of much concern.

The western end of Lake Erie has a submerging shoreline, with extensive areas of wetlands inside the beach bars. The flow from the Maumee varies from day to day, month to month, and year to year. With low water it flows eastward and with high waters it flows back and is subject to seiche movements common to Lake Erie. The bay is truly estuarial in character.

The removal of vegetative cover from the land has created muddy streams which smothered out the native plant life. Marsh vegetation flanks the upper parts of the estuarial ponds. Earl L. Core, biologist of the University of West Virginia, surveyed the aquatic plants of western Lake Erie in 1949 to record the changes during the last fifty years since the survey of 1899. He concluded that there has been a significant reduction in the amount of aquatic vegetation, and he considered possible causes were changes in lake levels, water movements, carp feeding habits and agricultural activity.

Eutrophication of the lake due to the vast in-pouring of nutrients and other pollutants has caused the acceleration of unwanted plant growth. Algae blooms have become a threat.

The Maumee was once the best smallmouth bass fishing area in the middle west. Increase in the quality of the catch is coming back very slowly with the decline in pollution and with new regulations in force.

Ducks, terns and gulls use the bay waters, but are now reduced in numbers. However, islands created from dredging spoil might prove valuable as nesting sites if dedicated to wildlife instead of being used for commercial development. Gulls and terns nest on small islands already in the bay. Although many studies have been made in the past, the bay's ecology has been ignored in recent years. It is the area that nobody knows, except for commercial development. There is a strong movement to correct this situation in order that ecology and economy can be associated for the long term good.

Although there are many facets to Lake Erie's environmental and pollution problems, it is the acquatic life organisms from the smallest algal cells to the largest fish that have borne the brunt of the changes and are the prinicipal vectors for transmitting the effects of change to man. Despite the tremendous value of the fishery of the lake, including the bay, pollution is steadily destroying its worth. Accelerated enrichment, unabated pollution — in spite of tremendous efforts to install pollution control—over-exploitation, and introduction of exotic species, have all been guided or misguided by man.

There has been a drastic shift from high-value fishes to medium and low value fishes. The lake trout, northern pike and sauger catches in quantity are now a thing of the past. Sturgeon, whitefish and cisco have become nearly extinct. Emphasis now is on catching medium value fishes like yellow perch and white bass. Destruction of the valuable mayfly benthos, a 20% increase in plankton, the diet staple for several nuisance and low value fishes, increased levels of mercury in many fishes, and the destruction of spawning areas of the most valuable fishes have been caused by industrial, municipal and agricultural pollution and enrichment.

Measures taken by the State of Ohio to save the walleye by prohibiting commercial fishing have stirred support from many sport fishing groups. First to protest filling the bay for Facility No. 3 of the port are the Lake Erie Wildfowlers.

A recently received communication from the National Environmental Protection Agency to the District Corps of Engineers asks for a revision of the impact statement previously filed on dredge spoil disposal. This is based on anxiety that significant environmental damage may result from execution of the long range Port Authority plan which is proposed under the present law. A coalition of citizens' groups is requesting a series of scientific studies, including a bottom sediment survey of the harbor area, prior to construction to determine existing conditions in the harbor and to serve as part of baseline data to evaluate the environmental effects of this project.

There should be a detailed discussion of the spawning beds in terms of their uniqueness, attraction, and type and populations of fish associated with the different spawning beds, and the role that the beds play in lake-wide and local fish propagation. Questions such as how much spawning area has previously been eliminated in Maumee Bay and what are the effects on birds and mammals need to be answered. So far studies of this nature have been turned down because the Maumee estuary has been considered too complex to analyze at this time. However, two programs are underway: the Plan Commission and the Toledo Metropolitan Area Council of Governments are conducting a study for the planning and development of the lower reaches of the river, and the Great Lakes Basin Commission Level B Study of the Maumee was included in the President's budget to be funded for three years at a cost of $1,500,000. The bay is not included, but the bay is what the river makes it, and plans for its development will come under scrutiny.

Tours are not conducted by the Port Authority, but an automobile or bus tour might begin at Bay View Park on the west side of the river, follow Summit to Broadway to Logan, to Erie to DiSalle Bridge (I-75), to Miami to Front Street to St. Lawrence Drive. A parking lot and observation deck have been provided at the overseas cargo center on the east side.

From the vantage point of the Cherry Street bridge or the observation platform one can get a good view and a feeling for the scope of this port, which has docks spread seven miles up the Maumee, helping to make it the world's leading mover of soft coal. Big Lucas, the city's enormous heavy lift crane, is in evidence, and students can watch him and many smaller ones at work. A grain elevator holding two million bushels of grain and gigantic molasses tanks are nearby. More exciting is the inland foreign trade zone where goods from foreign freighters may be unloaded, repacked, sorted or transferred to other ships without being charged import duties. From the port, too, move products for which Toledo is world famous—jeeps, spark plugs and all kinds of glass (Marion Renick, *Ohio*, Coward McCann, 1970.) To a critical mind, a view of the port raises the question how pure air, clean water, and a healthy ecology can be restored and maintained amidst all this activity of cranes, ships, and power plants—to the long range benefit of all.

Bus trips can be arranged with the Toledo Area Regional Transit Authority. Phone: (419) 243-1241.

For further information contact: Port Authority, Public Relations Department, 241 Superior Street, Toledo, Ohio 43604, Phone: (419) 243-8251.

Toledo Municipal Area Council of Government, Toledo, Ohio 43604, Phone: (419) 241-9155.

Great Lakes Basin Commission, 220 Huron Street, Ann Arbor, Michigan 48108.

SWAN CREEK

Location: Swan Creek is a major watershed among several Maumee River tributaries of the area. It consists of almost 204 square miles in Lucas, Fulton, and Henry counties. Originating in Fulton County, it meanders 45 miles southeasterly toward Toledo where it enters the Maumee River about three miles from Maumee Bay near the city's downtown.

The purpose of this study is to delineate areas suitable for study, education and recreation and to indicate briefly the effects of a Public Law 566 Small Watershed Project for the stream.

Historically, Swan Creek emptied into the Maumee estuary near where the Ottawa River enters; a narrow slip of land separated them. At that time, Swan Creek had the typical drowned estuary of streams entering the south and western waters of Lake Erie and the land at its mouth was heavily timbered with patches of swamp. The mouth then was 200 to 300 feet wide and overgrown with sub-aquatic plants including pond lilies, rushes and wild rice. It was affected as is the Ottawa River by the wind-induced tides or seiches of Lake Erie as far as three miles upstream. Recent studies indicate there is, even today with its mouth three miles further upstream, an effect from these seiches. The old mouth is the site of three attempted townsites and the former stream bed was the bed of the Wabash and Erie Canal which entered the present Swan Creek at Erie Street in Toledo.

Drainage in the area is a problem due to the flatness of the terrain. The gradient of Swan Creek is about 2.1 feet per mile, almost the same as that of the Maumee River. The creek runs through calcareous lake bed soils. There are both heavy clay soils and sandy beach ridges although Swan Creek skirts the deeper sand areas of the Oak Openings. The bedrock is shale and limestone. A dolomitic outcrop occurs in the bed of Swan Creek near Monclova, Ohio. It has four major tributaries: Ai Creek, Blue Creek, Wolf Creek and Cairly Creek. The upper reaches of Swan Creek are characterized by sharp bends and the formation of small ox-bow lakes due to the natural stream development in the main channel. Many man-made ditches flow into Swan Creek and its tributaries, contributing to the flow. The lower part of the stream is much like a slow millstream most of the year. Unlike the nearby Ottawa River, it has never gone dry, to our knowledge, although in drought years, it has been considerably reduced in volume.

A great deal of the streambed passes through wooded areas including Oak Openings Metropolitan Park and Swan Creek Metropolitan Park; 75% of the watershed is in cropland and pasture, 16% is wooded. In the wooded portions are found skunk cabbage, trillium, hepaticas, bellflowers, wood nettles, asters, goldenrods, violets, squirrel corn, cone-flowers and Indian pinks.

The trees in the cropland sections are most apt to be cottonwoods, buckeyes and sycamores. The black and red oaks predominate elsewhere. Some willows, ash and hawthorns are found. Formerly there were many chestnuts, beech and hickory, but due to clearing for farming, most of these are gone. One area of the watershed near Monclova has about 50 varieties of shrubs and trees, including 18 to 20 species which are among the largest in Lucas County. Here are found Kentucky coffee tree, sassafras, red and pin oak and cottonwoods as well as sycamore and willow.

Animal life, for the most part, is confined to the smaller forms among mammals; voles, shrews, woodchucks, skunk, red fox, opossum and raccoon. White-tail deer are found, however, in some of the wooded areas.

Fishes of Swan Creek are several species of darters, large-mouth bass, sunfish, bluegill, bullheads, minnows, shiners, carp, chub, suckers and gizzard shad. Most prevalent are the chubs and sandshiners.

No information is available concerning the invertebrates of the stream. Inasmuch as some of the other northwestern Ohio streams are known to be among those having some of the most diverse mollusk population in eastern North America, this should be studied. Some species found in other northwestern Ohio streams are found nowhere else in the world.

Croplands predominate in the watershed, some of the most productive croplands in Ohio. Due to the extensive agriculture, there is a heavy load of enriched silt. There is also some industrial pollution from the village of Swanton originating from plastics manufacturing. However, the largest burden of pollution starts once the stream crosses the western edge of the Toledo metropolitan area. The inputs are largely silt and organic wastes, but leaking septic tanks, combined sanitary and storm sewers and suburban sewage treatment plants contribute their share. A new treatment plant near Waterville is intended to alleviate some of this. Much needs to be done to utilize it fully.

The wooded portions of the watershed are largely those within the two metropolitan parks. Here there are opportunities for recreation, both scheduled and unscheduled. Swan Creek also passes through a natural area established by the Maumee Valley Country Day School. The Medical College of Ohio owns a portion of the abutting land that would be suitable for extension of a trail. Also, within the city of Toledo, Highland Park lies in the flood plain of the creek. A contemplated trail running from Reynolds Road (where the Maumee Valley lands are) extending through Swan Creek Park, the medical college and state hospital lands, thence through an urban wooded area to Highland Park and down Delaware Creek to the Maumee River has been considered, but the problem of obtaining sufficient easements through some of the private properties involved has blocked progress in this direction.

In 1966, Public Law 566 Small Watershed Project was proposed through the Soil Conservation Service for 24,000 acres of the watershed (approximately ⅕ of its total acreage). The purpose was to alleviate "flooding" in the headwaters area. Three alternative plans were offered: one involving three dams, two on Swan Creek itself and one on Ai Creek; Ai Creek, Wolf Creek, Upper and Lower Swan Creek all to be deepened and graded with only clearing and snagging within the city limits of Toledo; or a combination of the channel improvement and a single dam on Ai Creek.

There has been some opposition to the plan, because of the damming and destruction of bottom life and, in part, because of augmented flow which could increase flooding in the City of Toledo where there are a number of homes in the flood plain. Supporters believe the augmented flow to be necessary to alleviate flooded fields and point to the project as one which would also alleviate pollution.

Within Oak Openings Park, the park district has for some time considered the building of a lake in a natural depression (flood plain of Swan Creek). The hope is to obtain this through damming Swan Creek near where it crosses SR 295. Much of the woody growth has already been cleared from this area, but no funding has been allocated to this yet. It should be noted that the park district has, after many years without dependable funding, obtained its own levy and may feel that it has monies for this project now. Both Blue Creek and Wolf Creek have been proposed for additional Public Law 566 projects.

Due to the flat terrain of the area, there is a legitimate question as to what constitutes flooding and what constitutes lack of drainage. Heavy rainfalls do not drain from fields of the area due to the underlying till. It does not seem feasible to implement a Public Law 566 which would drain wetlands, but not necessarily do as thorough a drainage as would be necessary for the farms of the area. Where this particular project is concerned and as government funds are involved, it may be less expensive to purchase the flood plains rather than pay for draining them. This would also make available more recreation lands as it would provide public access to fishing and hunting areas. Inasmuch as such lands also help to retain water table levels, this should be considered and, if needed, state legislation could be introduced to make such purchases possible, here as well as in other similar situations.

It should also be noted that the 566 proposal would not clear up pollution. In fact, it increases siltation for a considerable period following completion of the project.

The Oak Openings Park lake, while it is feasible and might add to the recreational facilities of the park, should be examined in the light of the amount of siltation which would be trapped behind the dam. If it should be undertaken, a proper siltation basin should be constructed which could be periodically cleaned.

Swan Creek can be most easily viewed at the two metropolitan parks on its course. These are open from 8 a.m. to dusk. More information concerning the visitor centers at both parks as well as naturalist services and trails can be obtained by contacting the Toledo Metropolitan Park District, at 911 Madison Avenue, Toledo, Ohio.

The cropland segments of the stream and the urban portions involve private lands under many ownerships. Access to any of these would have to be arranged through the owners individually.

TIFFIN GLASS PLANT

Location: on Vine Street in northwest Tiffin.

Tiffin Glass is suggested for study because it represents one of the early glass plants which is producing a quality product from raw materials, is advantageously situated, and conducts good educational tours. The physical and chemical changes in the wide range of minerals present a view of the many aspects of science that converge in glass making. The use of water, electricity, gas, oil, machinery and labor are aligned with resource management, air and water quality and energy uses. Culturally the products are important as objects of beauty and graciousness.

Historically, the Tiffin Company dates back to the late 1800's, corresponding to the development of the glass industry in the Toledo area. From the beginning it has been relatively small, with a specialty in quality blown glassware. It became known as Tiffin Glass in the 1930's when the U. S. Glass Company sold its holdings. After a variety of vicissitudes in 1963, at a time when many glass companies throughout Ohio, Pennsylvania and West Virginia were facing financial crises, Tiffin went bankrupt. By means of community support, the former owners managed to begin business again, and in 1969 the company was purchased by Interpace Corporation, who gave new impetus to the industry.

A tour through the plant begins with a quick look at the outlet store where groups assemble. Fine ware is on display and for sale, but many popularly priced items are available, also.

A look at the raw materials which are combined to make glass is not always included in the trip through the plant. However, high school groups should request that this part of the tour not be omitted.

Basically, seventy-five percent of glass is quartz, chemically known as silicon dioxide, and a fine, pure quartz sand is necessary. Tiffin procures this product from a Pennsylvania company which processes sandstone layers of rock. Occasionally beach sands are used. One or more of thirty minerals are combined in a dry mix, minerals which contribute to the melting process, viscosity, removing excess gases, strengthening or coloring the glass. Soda ash, derivative of calcium carbonate and sodium chloride (limestone and salt), is needed to melt sand. Potash can be used as a substitute for soda ash but is more expensive. Limestone modifies the glass viscosity so that it can be worked satisfactorily. Litharge is a source of lead and also modifies the viscosity particularly needed for fine crystal.

Nitre aids in the refining of glass or removing excess gas. Antimony serves the same purpose. For strengthening glass, borax is added.

Chemicals are used to make glass clear, and the fine crystal produced by Tiffin is famous for that property. Colorants are added in some of the fine ware but are particularly important in the casual compotes, glasses, sherbet dishes, vases and other items. Titanium dioxide yields an orange color; violet is produced by manganese dioxide. Sodium diuranate is a source of uranium which provides a yellow color, as does cerium hydrate. For a pink or red color it is necessary to use selenium. Chromium oxide is a source of the color green, and potassium dichromate provides another shade of green. Blue comes from powder blue, a cobalt oxide.

The materials are weighed and the desired amounts for a specific kind of glass are combined to form a "batch." These are taken to the furnace room where they are subjected to high temperatures in a large furnace. A "gather," which can be compared to a handful of material, is removed from the furnace at the end of a blow pipe and handed to the master, who places it in a mold and blows it to the hollow shape. Other workers level, trim and add the stem, which is fashioned in the same way. At each station, excess or defective glass is saved and returned to a crusher to be recycled. Worn out refractories (ceramic furnace units), machinery and contaminated materials are periodically hauled to the dump.

The plant contains two furnaces used for this operation, one of which cannot be operated constantly due to lack of skilled labor. There are 250 employees, some highly skilled. These people come from a wide area, but the supply does not meet the demand. A number of young people are presently learning the trade on the job. Large industries in the region tend to draw away the available labor supply. The greatest cost in production is labor; the raw materials are comparably very low in cost.

Blown glass is the specialty of the plant, but one furnace with contingent machinery and workers produces less expensive casual table glass. It has 10 molds operated mechanically compared to the single blown glass operation.

The glassware on a conveyor belt moves through a tempering process. The casual ware is inspected and boxed for storage. The stemware is washed in one of the world's largest automatic dishwashers and those pieces requiring hand etching or other decoration are sent to designated stations. Gold, silver and platinum may be applied on special ware after craftsmen put on an etching design and the glassware has been in an acid bath and the dishwasher. Some of the ware is washed several times before it is ready for packing. It is fascinating to watch the skilled craftsmen as they add the finishing touches to the already artistically fashioned glassware.

The energy source for the furnaces had been gas until the fall of 1972. At that time the plant was required to convert to oil heat during the winter months, and officials recognize the possibility that this requirement will continue or even increase.

BEST COPY AVAILABLE

Water in the plant is used for cooling, dishwashing and sanitary purposes. Sanitary waste is discharged into the municipal sewage treatment plant. Chemical waste including detergents passes through a series of sumps or settling tanks where it is treated prior to discharge. In the near future a neutralizer, along with sophisticated monitoring equipment, will be installed to control this process.

Workers who handle the uranium are checked monthly by government inspectors and thus far (1973) the reports have indicated minimal radiation pickup. Air pollution from the gas and oil furnaces is negligible.

The Tiffin plant personnel give school and group demonstrations upon request: four tours a day during the summer, two during the winter months, and school groups as requested. Participants must be six years of age or older. Trips for elementary students are geared to their level. Contact: Director of Public Relations, Tiffin Glass Company, Tiffin, Ohio 44883, Phone: (419) 447-5313.

Tiffin Glass

ADDITIONAL MAUMEE RIVER WATERSHED SITES

Auglaize River Power Dam, on River south of city, Defiance 43512, Defiance County.

A good site for studying river ecology, this area is accessible during low water stages. The dam is no longer used for generation of power, but the impoundment remains. Water quality, land use.

Auglaize Village Woods, west of Defiance off US 24, Defiance 43512, Defiance County, contact: Defiance Historical Society, Defiance 43512.

A preserved black swamp forest with stands of hickory and swamp white oak, a valuable glimpse into early northwest Ohio conditions. Resource management.

Beaver Creek Wildlife Area, six miles north of Bryan, east off SR 15, Bryan 43506, Williams County, contact: Division of Wildlife, 952 Lima Avenue, Findlay 45840, phone: (419) 422-6757.

A natural environment involving old lake beach ridge, beech-maple forest with flood plain species of trees in lowland. There is good contrast between moraine and beach ridge uplands on northwest and Black Swamp area on the southwest. Stream studies show abundant life.

Bryan Canning Company, 620 East Perry Street, Bryan 43506, Williams County, phone: (419) 636-3454

This company specializes in the canning of tomatoes. It has recently installed expensive sewage treatment plant. Resource management and water quality.

Camp Hertzer, located on County Road 33, five miles north of Tiffin, Tiffin 44883, Seneca County, contact: C. W. Lutz, 465 East Perry Street, Tiffin 44883, phone: (419) 447-5963.

This is a camp on the east bank of the Sandusky River where water, reforested farmland, mature forest and grasslands studies may be conducted. Land use, resource management, water quality.

Camp Michael Youth Community Camp, Seven miles southwest of Bucyrus on Shipp Road, Crawford County, contact: Douglas Wilson, c/o Jay's Toggery, North Sandusky Avenue, Bucyrus 44820, phone: (419) 562-1236 or Camp Michael, phone: (419) 562-2764.

A site for studying river life, sedimentation and vegetation along the Sandusky River. Adjoining properties belonging to Dr. Paul Sears and Charles Tschanen may be included in the field course. Water quality and land use.

Campbell Soup Company, on east side of Maumee River, north of Napoleon, contact: Tour Director, Campbell Soup Company, Napoleon 43545, phone (419) 592-1010

A tour through this outstanding food processing plant can be arranged for high school classes on Tuesday, Wednesday and Thursday from November 15 to June 15.

Cooper Tire Company, at Lima and Western Avenues, south side of Findlay, contact: Public Relations Director, Findlay 45840, Hancock County, phone: (419) 423-1321.

A limited number of tours are given to high school students or older for educational purposes.

Cranberry Township Brick Arch, located ½ mile south and west of New Washington, contact: Herbert Harrer, New Washington 44854, Crawford County, phone: (419) 492-3571.

Well worth studying for its historical and geologic value, this tunnel was a drainage ditch in 1892 for an extensive cranberry marsh. The engineering difficulties encountered were met in a unique way.

Deep Cut Park, located on west side of SR 66 on the county line near Spencerville, Spencerville 45887, Allen County.

Deep Cut refers to a 6600 foot long excavation through a glacial moraine for the Miami and Erie Canal system. The site has been named a National Historic Landmark.

Defiance City Sewage Plant, on SR 424 west of city, contact: City Building, Defiance 43512, Defiance County, phone: (419) 784-2101.

A tour affords observation of unusual secondary treatment facilities and the "Limpro" digestive process. Water quality.

Dura Sanitary Landfill, at 444 Dura Avenue, Toledo, contact: Manager, 2411 Albion Street, Toledo 43606, Lucas County, phone: (419) 255-1500.

This 67½ acre site is now used as a landfill but will eventually become a park facility. Methods of handling refuse and cover material are worth observing. Land use and resource planning.

Fondessey Enterprises, Inc., 876 Otter Creek Road, Toledo 43616, Lucas County, phone: (419) 726-1521.

This company maintains and operates a sanitary landfill for the disposal of solid wastes of the city of Oregon. Guided tours may be arranged. Air and water quality.

4-H Camp Palmer, southwest of Fayette near Harrison Lake State Park, contact: County Extension Agent, 4-H Key Building, Wauseon 43567, Fulton County, phone: (419) 335-9071.

Marked nature trails and winterized facilities are new features at this site. Stream study and a reforestation program may be observed. Resource management, water quality.

Indian Mill State Memorial and the Sandusky River, off SR 23, 3½ miles northeast of Sandusky, Sandusky 44870.

An original mill portraying the era when the state's basic economy depended on the grains milled. It is the site of Wyandot Indian activities. Its location on the Sandusky River provides an opportunity for river study. Resource management and water quality.

Killdeer Plains Wildlife Area, southwest corner of Wyandot County, off US 23 and south of Harpster, contact: Manager, Killdeer Plains Wildlife Area, Route 1, Harpster 43323, (614) 469-2254.

This flat, glacial lake bed contains marshes and water areas for study as well as rich wildlife habitats. Nesting and migrating waterfowl; prairie plants are outstanding. Resource management.

Lima Lake and Lost Creek Reservoir, both at Lima in Allen County, contact: Director of Utilities, Lima 45802, Allen County, phone: (419) 229-2891.

Two upground reservoirs provide the city of Lima with its water supply. These are typical installations for the flat northwest section of Ohio. Resource management and water quality.

Magee Marsh and Crane Creek Wildlife Experiment Station, located on SR 19 and 2, 10 miles north of Oak Harbor, Contact: Supervisor, Crane Creek Wildlife Station, Route 3, Oak Harbor 43449, Ottawa County, phone (419) 897-2523.

These extensive marsh lands and headquarters for wildlife waterfowl research and management projects are unusually excellent sites for studying birds and resource management. A full time naturalist is available.

Medusa Portland Cement Company Quarry, on Centennial Road, west of Toledo, contact: Medusa Portland Cement Company, P.O. Box 310, Sylvania 43560, Lucas County, phone: (419) 841-3324.

This quarry is valuable as a resource management situation but is also a choice place for fossil hunting. The lower units are rich in bulobites, corals, brachiopods and bryozoa. Permission must be obtained from the quarry office on the site and a liability release signed.

Northern Ohio Sugar Refinery, off I-75 and SR 15, south edge of Findlay, contact: Director of Public Relations, Logan Avenue, Findlay 45840, phone: (419) 423-2151.

Special tours may be arranged. Resource management, air and water quality.

Ottawa National Wildlife Refuge, borders Lake Erie off SR 2 between Toledo and Port Clinton, contact: Manager, Rt. 3, Oak Harbor 43449, Ottawa County, phone: (419) 897-2521.

The only federal wildlife refuge in the state, this extensive acreage consists of diked marshes and farmland with a few woodlots. Bald eagles nest here, birds and other small animals abundant. It is adjacent to Crane Creek State Park. Land use and resource management studies.

Secor Park and Arboretum, on Central Avenue, eight miles west of Toledo, contact: Toledo Metropolitan Park District, 911 Madison Avenue, Toledo 43624, phone: (419) 255-1400.

Trails through natural woodland, an extensive arboretum and a nature center.

Swiss Farm, Bluffton College Outdoor Education Center, located north of campus, contact: Naturalist, Swiss Farm, Bluffton College, Bluffton 45815, Allen County, phone: (419) 358-8756.

This center is an excellent field laboratory for the study of a wide variety of habitats including a pond for water quality tests. A library, films, exhibits and lectures provide teacher helps. Land use, resource management.

Terwilliger's Pond, Put-in-Bay Harbor, South Bass Island, contact: Anne Benninghoff, 3315 Alton Court, Ann Arbor, Mich. 48105.

This site is a lagoon at the mouth of an intermittent stream which now drains farmland and vineyards. It has been extensively studied because of its vegetation and soil features associated with water level changes. Further studies could be very challenging.

Toledo Demolition Services Dump, 2020 Manhattan Blvd., Toledo 43611, (419) 726-4533.

This is a former dump converted into a sanitary land fill to be used for the disposal of inorganic wastes.

Toledo Edison Generating Station, Bay Shore Road, East Toledo, contact: Public Relations Office, Bay Shore Road, Toledo 43616, (419) 259-5198.

A relatively new installation which arranges tours for students 15 years or older.

Toledo Museum of Health and Natural History, 2700 Broadway, Box 4247, Station E, Toledo 43609, Lucas County (419) 385-5721.

The museum offers an opportunity to visit zoological gardens and exhibits in health and biological specialties.

Toledo Zoo, 2700 Broadway, Toledo 43609, Lucas County, phone: (419) 385-5721.

This zoo has a large variety of animals, including baby animals, and plants; also a museum of science. Free to students and teachers.

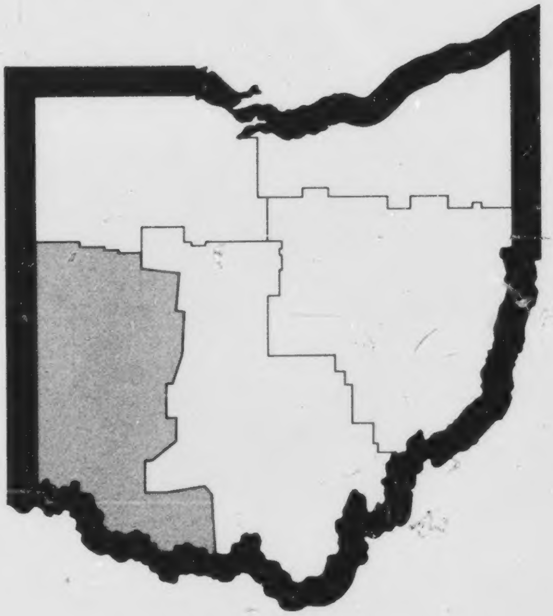
Williams County Conservation League Area, located five miles north of Bryan, off SR 15, contact: Robert C. Kunkle, 202 Fulton Road, Montpelier 43543, Williams County, phone: (419) 485-4429 or C. Hobart McKarns, 1104 Wellmore Circle, Bryan 43506, phone: (419) 636-1386.

This is an excellent site for pond study with an abundance of aquatic life, beech maple forest with many other tree species and wildlife. Picnic facilities.

Woodlawn Cemetery, at Central and Auburn Avenues, Toledo, contact: Toledo Naturalists Association, 3831 Homewood Ave., 43612, (419) 475-7012.

A large, wooded cemetery noted as a good birding area. It is good for rock weathering studies, also.

The Miami Watershed Region



BACKGROUND INFORMATION

Biophysical Environment:

There are two Miami River valleys in this region, the Great and the Little Miami. In addition, the shorter streams draining into the Ohio River, namely Mill, Ohio Brush, Eagle, Straight and Whiteoak creeks are contained within its boundaries. Brown and Adams counties are encompassed, as well as Mercer and Auglaize, even though in the last instance the Auglaize River headwaters (which flow into the Maumee Watershed) are within this region. The total area estimate is 6000 square miles.

The southwestern corner of Ohio is underlain by Ordovician strata representing the oldest exposed rock formations in Ohio. They are found at the crest of a low arch known as the Cincinnati Arch or Anticline, the result of a gentle uplift from internal earth movement. The rock layers were deposited in a fluctuating warm shallow sea as layers of limestone and shale. This limestone is made up of shells and shell fragments, the remains of the multitude of small marine animals which lived and died in the Ordovician sea. Trilobites were a dominant form in the late Ordovician but distributed throughout are also brachiopods, bryozoa, colenterata (corals), crinoids, cephalopods, gastropods and pelecypods, all bottom dwelling forms. During the 300 million years since these sediments were deposited, more strata may have been deposited on top of these beds or there may have been a long period when the arch served as an island. No trace remains to tell the story.

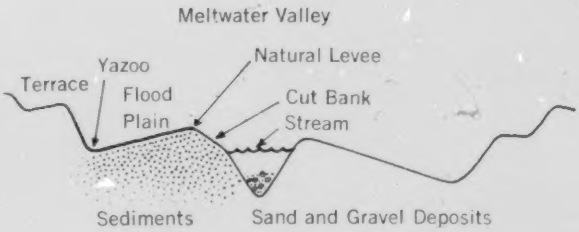
Surrounding the Ordovician rocks like slices of a partially peeled onion are strata of younger rocks, the Silurian age dolomites, thin-bedded limestones and shales. Streams have eroded through the rock, forming narrow valleys and wide ridges with spectacular scenic results in many places. Waterfalls are frequent where the resistant dolomites and sandstones form a shelf-like overhang with softer, easily eroded shale beneath.

The invasion of ice was geologically recent—only a little more than a million years ago! Three of the four major currently recognized ice advances have left their marks in the Miami Region: the Kansan, probably about 1,200,000 years ago; the Illinoian, 400,000 years ago; and the Wisconsin, 110,000 to 20,000 years ago. The furthest advances are marked by end moraines containing polished and striated cobbles and boulders from Canada.

Southwestward from Columbus the last ice sheet, progressing slowly, failed to reach the boundary of the previous glacier. It was the earlier Illinoian sheet which extended to the present Ohio River, which gave the river its present course in the Cincinnati area as a marginal stream around the protruding lobe of Illinoian ice. Great floods of meltwater from the wasting glacier poured from its front depositing coarse sand and gravel, called outwash, into the valleys, deepened and widened by the volume of this water. Later some of these gravels were cemented by percolating groundwater carrying dissolved limestone and now make conglomerate cliffs where exposed by stream action.

The typical glacial meltwater river valley is an intriguing phenomenon to watch for in Ohio. The valley profile shows a V-shaped stream course with cut banks and natural levees on either side. Beyond the natural levees, formed because the stream at flood stage drops its heavier materials as it overflows its banks, the silt-laden water floods its flood plains and deposits the sediment held in suspension. These are the clays and silts that enrich flood plain soils and make them valuable for agriculture. A yazoo, named for such a stream along the Mississippi River, is usually found at the terminal edge of the plain. This is a backwater area collected against the former cut banks because the plains slope gently away from the natural levee. The cut banks reach to a terrace level, an earlier flood plain. Still earlier cut banks may then extend to the till plain or erosion level.

TYPICAL PROFILE OF GLACIAL RIVER VALLEY



Into the bare areas left by the glacier, trees and other plants began their migration. This process continued until Ohio was covered with forests. The pioneers found several forest associations: mixed hardwoods along the Ohio River and upstream in the major river valleys; beech-maple forests in the well drained parts; and "swamp forests containing oaks (pin, swamp white, and white), red maple, sweet gum, and beech with an admixture of hickories" in abundance in the poorly drained Illinoian till sections. The original forests are now largely replaced by farms and second-growth pin oak and sweet gum stands (E. Lucy Braun, *Forests of the Illinoian Till Plain of Southwestern Ohio*, 1936).

"All environmental factors—climatic or atmospheric, physiographic, soil or edaphic, and biotic, both present and past — affect the geographic distribution of species. Sometimes one factor, sometimes another, may be determinative; however any factor acts in conjunction with all other environmental factors" (Braun, *The Woody Plants of Ohio*, 1961).

Fossil evidence of animal life during and following the last stage of glaciation indicates that the inhabitants were ground sloth, mammoth, giant bison, musk ox, giant beaver and other large life forms. These were replaced by the bear, elk, deer, rabbit, quail and wild turkey of Paleo-Indian time and later. Presently the area is so heavily populated with people that these species are rare.

Socio-Cultural Development:

The prehistory of man in this region probably correlates his movement with that of animals coming in after glaciation. The river systems were early transportation routes for Hopewell Indians who located in central and southern Ohio concentrating along the Great and Little Miami systems as well as the Scioto. These amazing people dominated the southern half of Ohio for nearly 1000 years. Their economy was based on hunting, gathering, fishing and some farming, but they developed an impressive social structure which made it possible to construct great earthworks. Evidence of art and architecture, trade, weaving techniques, and other cultural developments is left as a heritage of an energetic, intelligent people.

The Miami valley has served as a corridor for two races since that day. The Miami and Tawichtawis Indians occupied the area at the time of the earliest penetration by white men. Fierce battles were fought for supremacy. The French regarded both the Great and the Little Miami valley as the right-of-way to their settlements in Louisiana. The British considered it their principal route from tidewater colonies to the last stronghold of the French at Detroit. Both sought to preserve the region for the exclusive use of the Indians, whom they attempted to make allies.

Settlement began after exploration revealed the two Miami valleys to be rich and fertile. The first actual settlement in 1788 was on a grant from the Symnes Purchase, a controversial strip between the two valleys a short distance below the mouth of the Little Miami. This settlement was soon over-shadowed by Fort Washington, built at Cincinnati in 1789, which became the headquarters from which colonial generals set out on expeditions against the Indians.

Settlement soon spread northward, eastward to the Virginia Military District, and westward to the Indian territory just beyond the state boundary. By 1810 the larger towns were established: Dayton, Hamilton, and Cincinnati. Present names reflect the fact that the early people came from the "Old South"; Greenville, Jamestown, Washington Court House and Alexandria. From the earliest days, however, Ohio was built by the blending of many colonial strains. For example, enterprising people from southeastern Pennsylvania and western New Jersey found their way into the Miami country, West Chester, Gettysburg, Trenton, Germantown and Camden reflecting this migration.

Immigration from European countries to Ohio before the Civil War was primarily from the German states, Ireland and Great Britain. Before 1825, the Irish in the state as a whole were largely Scotch-Irish Presbyterians, although early records make no distinction between Protestant and Catholic newcomers from Ireland. "By 1833, however, John Baptist Purcell, a native Irishman, became the Roman Catholic bishop of Cincinnati and by 1850 there were nearly 52,000 of his countrymen in the state" (Carl F. Wittke, *These Ohioans*, main address commemorating the 150th Anniversary of the Statehood of Ohio). Great numbers settled in northern Ohio during the Irish famine years of the 1840's. (See Cuyahoga-Grand Watershed Region.)

There were Germans in almost every county of the state as early as the 1820's but immigration began in large volume after 1830. For the most part the newcomers were farmers and artisans who were sturdy, hard-working and thrifty. These people became an important part of Ohio's stable middle class. "By 1850, 27 percent of Cincinnati was German, and across the Miami Canal, in a district known as 'over the Rhine' German burghers congregated, especially on Sundays, to drink their lager beer, smoke their pipes, listen to concerts in beer gardens, and sing the songs of the fatherland" (Wittke, *op. cit.*). Political upheaval in Germany was a factor in bringing to this state a remarkable group of reformers, good musicians, newspaper publishers and political adherents. There are numerous instances that indicate a very strong political and cultural influence exerted by Germans during the development of this region.

The greater part of southwestern Ohio lies on undulating, productive soils interspersed with dark, equally productive, but poorly drained soils. It is on these soils that agricultural excellence of the valleys depended and in the years of settlement gave self-sufficiency to the pioneers. Agriculture, after a century and a half, remains an important part of the economy. In spite of this, less than 10% of the present wage earners work on farms, with a concentration of farms north and west of Dayton in Darke, Preble and Miami counties, north and east of Dayton in Champaign and Clark counties, with a smaller concentration in Hamilton and Clermont counties. In the northern farms, an extension of the Little Corn

Belt, there is general farming with livestock feeding, cash grain and dairying. Hybrid corn is frequently the largest crop and is accompanied by problems contingent to monoculture production. Livestock feed lots are an ubiquitous feature on the landscape and dairying has shown great increase due to city markets. Specialty crops include tobacco, although it is on the decline at present. Ohio growers originally came from the tobacco counties in Kentucky and settled on the hill lands just north of the Ohio River. Brown and Adams counties continue to be the state's leading tobacco producers. Another special crop is sweet corn, commonly grown on many of the bottom lands in the southern half of the region.

Part-time farming by well-to-do and poor alike is increasing in areas easily reached by commuters. The growth of cities has encouraged an important movement to the country, resulting in a burgeoning of small frame homes on lots near industrial complexes on one hand and new construction or remodeling of large homes on an elaborate scale, on the other. Huge shopping areas sprawl at intervals along the way.

The two-mile-wide Great Miami Valley and the Little Miami Valley have been and continue to be the source of sand and gravel. These have a constant value for construction and road building. Frequently the poorest part of a man's farm provided the greatest income for a period of time when he discovered the presence of sand and gravel. Limestone, too, has been valuable in the past as a building stone but is extracted now for agricultural lime, Portland cement, road material and flux for iron furnaces. There are two clay-producing counties in the region, Butler and Greene; the Greene County clay is used for the manufacture of cement, Butler's supply for clay products.

By far the greatest resource, the one most directly responsible for the tremendous industrial growth in this region, is water. Long stretches of the broad valleys contain wells capable of providing over 500 gallons per minute (See ground water resources map). "The lower Great Miami River Valley is favored with the most abundant reservoir of groundwater in Ohio" (Spieker, *Ground Water Hydrology and Geology of the Lower Great Miami River Valley, Ohio*, 1968). Estimates for this area state that individual wells are capable of yielding 3,000 gallons per minute.

"The ground water system should be able to meet all the expected demands on it until the year 2000 and then continue to be an adequate source of supply for many more years, provided that future sources of supply are intelligently planned and are located in favorable hydrogeologic environments.... Accordingly, man's ability to maintain adequate water quality will determine the extent to which this aquifer system can be developed" (Spieker, *op. cit.*).

The Ohio and Miami Rivers from the time of settlement were advantageous linkages for access and trade. There was little development of outgoing materials for many years although settlers leaned heavily on the products brought in from the South. With the opening of the canal system agricultural surplus was converted into salable goods. Every town had its flour mill, a tanner, a harness maker, a blacksmith and a cabinet maker. People of means were willing to pay for the best cabinet work, and the local hardwoods offered choice cherry, walnut, oak and maple for processing. Early woolen mills, procuring a substantial part of the spun yarn from local homes, made blankets, suitings and material for work garments. Many of these original industries are represented in the region today.

Since pioneer days when German settlers brought paper craft into the Miami Valley, the area has maintained an important paper industry. Changing sources of raw materials, process improvements, power development and transportation have been taken in stride by the manufacturers, and the industry remains significant to this day.

Farm implements, buggies and wagons were followed by the railroad equipment industry, which in turn was followed but not displaced by the automobile industry. The manufacture of airplanes followed shortly after World War I, in the same city where the Wright Brothers invented their flying machine earlier in the century.

At the present, almost two centuries after settlement, the economy of southwestern Ohio is dominated by manufacturing. The sequence of industries exhibits a quality of maturity which is marked by subcontracting, highly involved production and a higher value added to the manufacturing process. Machines are made to produce machines and specialization is extensive. Raw materials come from greater distances, sales have a wider geographic market, and labor supply, early augmented by ethnic migrations, now extends to non-industrial areas across the Ohio River.

Many plants have been established in the valleys because of the abundant water supply. Chemical and allied products, food and kindred products, steel mills and power plants are particularly heavy users. Mill Creek is one of the nation's major industrial areas, with literally hundreds of plants along the valley, expanding now upstream into Butler County.

Cities in the Area:

Ohio's other cities were still struggling settlements when Cincinnati was having symphony concerts, operas, dances and ladies paying calls in silk dresses. Established in 1788 on the site of the stockade, Fort

Washington, it was chosen capital of the Northwest Territory. Its location gained for it the name "The Queen City of the West." Before the Civil War it was the largest city west of Philadelphia and was an early, outstanding cultural center. German immigrants brought not only their language and beer but the Cincinnati Symphony Orchestra and Conservatory of Music, which became part of the University of Cincinnati, the state's first municipal university. In 1859 a German Jew, who had anglicized his name from Hecht to Pike, built Cincinnati's Grand Opera House, then recognized as the finest in the United States.

The cultural, social and political development of the city reflected industrial growth. Because great numbers of corn fed pork were brought in from the farms, pork fat was available for Procter and Gamble to make soap. The Fleishmanns produced yeast, Gruen made watches and Wurlitzer made pianos. Now power plants and atomic energy installations, aircraft engines, machine tools, transportation equipment and chemical plants increasingly multiply industrial dividends. The river front is more important than ever with a great volume of freight delivered on latched-together barges. Many fortunes have been made by families like the Tafts, the Procters, and the Gambles, who shared their wealth with their beloved city. A famous zoo, museum, and the first salaried fire department came upon the scene. In 1869 the Cincinnati Red Stockings were the first paid baseball club in history. The Reds and Bengals, the Cincinnati professional football team, now boast a handsome stadium, a newcomer on the riverfront. Suburban development has expanded into the hills surrounding the busy metropolis. Although the Ohio still endangers the riverfront with floods, thermal inversions threaten health, and water quality creates problems on the riverfront, the Queen City remains an important Ohio center.

A few miles north and west of Cincinnati on the Great Miami River is Hamilton, with a growing population, now almost 68,000. This city is a good example of a waterway linkage and functionally convenient expansion area. It stands on the site of Fort Hamilton, built in 1791 by General St. Clair as an outpost of Fort Washington. It began as a trading center for the excellent agricultural lands located in the Miami Valley. When enterprising Germans came into the region, the pioneer industries received a new lease on life; they contributed to the development of paper, wool and machinery. The "endless woolen blanket" was invented by a local citizen. It has since become important in the paper industry as a means of drying the wet cellulose in preparation for paper. The manufacture of stoves, safes and vaults, coke and iron and a multitude of machine tools, engines, cranes, milling machinery, shovels and draglines has developed to a high degree, taking advantage of the market relationships.

Lebanon, a small city in Warren County, located close to Cincinnati, has several notable episodes in its history. In 1803, before the city was founded, the Golden Lamb, Ohio's oldest tavern, was opened and has been operating ever since. In addition to an excellent cuisine it displays treasures typical of the Shakers, a communal group from Lebanon, New York, which established a settlement at Union Village, now just outside the city. The colony had strict religious principles and gradually dissolved because it did not appeal to the younger generation and celibacy diminished its size. The Shakers are remembered for their pioneer garden seed industry, their hogs, and their severely plain but graceful furniture.

Lebanon built a canal connecting with the Miami and Erie near Middletown, but little industry was attracted. A recent increase in population may well be due to its proximity to Cincinnati and Dayton, although fabricated metals, paper, petroleum, structural steel and other products are processed here. In addition to the Golden Lamb, many tourists are attracted to the Morgan Gold Cup Horse Show and to Fort Ancient, a nearby prehistoric earthworks, museum and wooded parkland on one side of the beautiful Little Miami River Valley. This is one of the most scenic parts of the Little Miami, which was designated by Ohio as a wild river in 1969.

Wilmington, sometimes called "The Garden Spot of the United States" (*Ohio Almanac*, 1970), is located east of Lebanon in the gently rolling country of Clinton County. The city (at present slightly over 10,000 people) was established in 1810 by Quakers who appreciated the fertile soil drained by tributaries of the Little Miami River. Some industries and manufacturing plants are present but the city is more renowned for the Friends Church and its college established in 1870. The influence of the Quakers persists today as evidenced by native sons, who, long removed from the Friends environment, lapse into the "thees and thous" of their Quaker heritage.

From its humble beginnings with a log cabin built in 1791 to a population of 48,000 people, Middletown has experienced a great metamorphosis. In 1825 construction of the Miami-Erie Canal began here. It was the home of the first Manila paper mill west of the Alleghenies as well as the home of George Verity, founder of Armco Steel Corporation, and John B. Tytus Jr., who invented the process for continuous rolling of sheet metal at Armco. A new Armco plant and many small industries reflect accessibility to market and raw materials. (See detailed description of Armco Steel plant).

Pioneer Dayton occupied the river terraces south of the Mad River and east of the Great Miami River. With this area as a nucleus, the city has spread in all directions with attenuations along the valleys of the two rivers. From the 36 persons who settled at Dayton in 1796, the city has grown to 269,000, with adjacent cities and villages totaling 400,000. This development took place in spite of warnings by the Indians that severe flooding endangered the area. These, in truth, materialized. The most disastrous flood destroyed $100 million worth of property in March, 1913. As the result, a flood prevention program under the direction of the Miami Conservancy District was developed, becoming the first of its kind in the country.

Dayton was the home of James Ritty, who first conceived the idea of a mechanical money drawer, resulting in the organization of the National Cash Register Company. Young Charles F. Kettering worked at NCR for a period of time and then with a partner formed the Dayton Engineering Laboratories (DELCO). His subsequent invention of the electric generator brought light and power to farms all over the country.

Near Dayton are the Wright-Patterson Air Force Base and the Air Force Museum, the largest military aviation museum in the world. Dayton's interest in aviation dates back to the days when Wilbur and Orville Wright built the first plane in their bicycle shop on West Third Street.

Recent developments of note are the Dayton-Montgomery Park System and the new convention center dedicated in January, 1973. Civic leaders seek to maintain Dayton as a thriving metropolitan area.

Located east of Dayton in Greene County, Fairborn is the county's largest city. It is a focal point for air activity, with Wright-Patterson Field and the Air Force Museum contained within its boundaries.

Xenia, the county seat of Greene County, is located east of Dayton, and Wright Patterson Air Base accounts for a large segment of its population. The principal industries are stone-clay-glass, rubber, metals, furniture, printing and food. The classic Greek name is attributed to a traveling preacher, who with his Bible and saddlebags stopped at the settlement. Grateful for the shelter and hot food given him by the pioneers, he declared the town should be named the Greek word meaning hospitality.

Near Xenia are Central State and Wilberforce Universities, educational institutions primarily for Blacks.

Nearby is Yellow Springs with Antioch College, founded as a non-sectarian institution with equal rights for men and women. Horace Mann was the first president (1853-1859); Arthur Morgan, of Miami Conservancy fame, was its president during a 1920 reorganization.

Clifton Gorge and John Bryan State Park are scenic and historic sites in the area, located on the Little Miami River where it cuts a gorge through the resistant Silurian rocks.

Located advantageously just 23 miles northeast of Dayton in the Mad River Valley, a tributary of the Great Miami, is Springfield. Historically the city was founded when George Rogers Clark, Simon Kenton and Daniel Boone moved into the territory and defeated the Shawnee Indians in 1780. Kentuckians, including Simon Kenton, settled here in 1801. The name is derived from the many springs in the area as observed by Kenton's wife. Being on the National Road, now US 40 and I-70, spurred development of the city. Springfield's proximity to Dayton, where the canal system enabled it to share in the important commercial activities of southwestern Ohio, was an important growth factor. The invention and subsequent manufacture of engines, turbines and farm machinery were important contributions as well. Hybrid corn and the 4-H Club movements originated in this city and it became the home of Wittenberg University, founded in 1845 by the Lutheran Church of America.

Troy, north of Dayton and also on the canal, was settled by Virginians and Kentuckians. It was once known for its wagon and buggy shops but today manufactures aircraft parts, paper products and food processing machinery. During the Civil War the city was a station on the Underground Railway.

The Shawnees named Piqua their word that means "born of ashes," because it is situated on the site of old Indian villages. It was a thriving canal town famous for the processing of local flax seed for oil. It now claims the only municipally operated nuclear power plant in the country.

Near Piqua is the John Johnston House, one of the few Indian Agency houses left in the U.S. It is a part of a restoration project of the Ohio Historical Society which embraces a section of the canal, with an operating canal boat, Lockington Locks, Fort Pickawillany, an English fur trading post, the site of Fort Piqua and a prehistoric Indian earthwork.

Any town in this section of Ohio has an interesting history. Worthy of mention, primarily because of its location near Ohio's highest point of elevation, is Bellefontaine. Geologically the area is situated upon a resistant limestone outlier of Devonian age which didn't get eroded away by the preglacial streams. The point served somewhat to deflect the glacier which formed two lobes, one moving south and west from this region, the other south and east. The town was built on the site of a Shawnee village. Still in use today is the first concrete pavement in the nation, laid around the city's courthouse in 1891.

Near Bellefontaine at West Liberty are the Piatt Castles, homes of prominent Civil War leaders, and Zane and Ohio Caverns, outstanding sites in Ohio.

Wapakoneta, named for an Indian chief, stands on the site of an old Shawnee settlement. Geographically it lies on the ridge in Auglaize County which divides the headwaters of the Ohio River and Lake Erie. More recently it has become famous as the birthplace of Neil Armstrong, the first man to set foot on the moon. Millions of people watched and heard Armstrong's words, "That is one small step for a man, one giant leap for mankind." A new museum (1973) houses intriguing memorabilia.

Man's Impact on the Environment:

The foregoing information tells the story of consistent change from early agricultural land uses to urban development and the persistent industrialization of the region. In the 1964 *Water Inventory Report, No. 18*, by the State Division of Water (The Little Miami and Mill Creek Basins and Adjacent Ohio River Tributaries), the present (1960) land use figures for Hamilton County were given as 88,090 acres in farm land, 176,870 acres for land not in farms; for Montgomery County, farm land, 197,000 acres; non-farm, 100,000 acres. Estimates for the year 1975 indicate Hamilton County will drop below 51,000 acres in farm land, giving a rising figure of 177,000 for non-farm land. Montgomery County likewise shows the same trend although it is not so pronounced: 172,000 in farm land, 125,000 acres, non-farm. In each of the counties in these two basins, even the ones with high acreages in agricultural use, the figures indicate less in farm land and more acres in non-farm land.

The report mentioned above further concludes that most communities outside the Cincinnati and Dayton metropolitan areas will be able to obtain future water supplies from wells (in the gravel aquifer) or directly from streams without impoundment. Expansion of water supply systems for the large metropolitan areas will require additional reservoirs, artificial recharge of groundwater by the recharge-well method, flood plain regulation and channel improvement.

Trends indicate continued rapid growth of the Cincinnati and Dayton metropolitan areas. Urban expansion is reaching into Clermont, Warren, Clinton, Brown and Butler counties from Cincinnati. Dayton's expansion tends toward Greene County. The prognostication of a megalopolis from Cincinnati through Dayton to Springfield and east to Columbus seems entirely valid.

Flooding has been a problem in the region since recorded time. Denuding the land of its forests and extensive agricultural uses have made their contribution to sedimentation in the rivers. But ice breakup on the Ohio River, heavy precipitation in the valleys, and in recent times the blocking of normal infiltration by paving, blacktopping, housing and industrial complexes covering great acreages, which serve to increase runoff as well make floods a threat. To combat flooding in the Great Miami Watershed, the Miami Conservancy District was formed in 1915. With power to levy assessments and user charges, the District initiated a flood control program building five earthen dams and levees in the urban areas within the district. These were engineered to protect the land against inundation with one and one half times as much water as the disastrous 1913 flood. Since the dams and levees were completed the protected Miami has not been ravaged by a major flood. Comprehensive study of flood control problems in the Little Miami has been recommended by the State Department of Natural Resources (*Water Inventory Report 18*, 1964) in view of damage from floods in 1959 and 1963. It is further recommended that the Mill Creek Conservancy District merge with the Southern Butler County Conservancy District. The planning efforts of this combination as well as those of the Little Miami River Conservancy District might be greatly enhanced if they were to join as sub-districts of the Miami Conservancy District, which has an organized staff experienced in water basin development.

The Miami Conservancy District in 1967 was charged by the State of Ohio with responsibility for planning, developing and guiding an effective program for improving water quality in the District's watershed. The District is not responsible for enforcement; only the state has that authority. To help man live in harmony with his environment, the District made these recommendations (some of which have been implemented):

1. Provide regional wastewater treatment plants. One has been constructed at the Franklin Environmental Control Complex (see detailed site study). The waste water treatment plant serves a 75-square-mile area including five paper mills, Germantown, Carlisle and Chatauqua. This is a model for regional treatment facilities now being considered for other areas. The District believes that the need for greater efficiency in the operation of existing sewage and water treatment plants is essential for water quality in the area.

2. Provide water quality management. The District has set up sampling stations along the Miami River and its tributaries. Computer technology makes possible a mathematical description of the river, a "model." Included are data on dissolved oxygen, stream flow, combinations of temperatures and other environmental conditions. The model will aid in determining the effect of new or increased pollution and in testing proposed solutions.

3. Enhance stream appearance. This is a program to clean out old cars, appliances and other debris dumped into local streams or on their banks. Supervised school teams from each metropolitan area have been used during the summer months of the last two years to achieve this goal.

4. Add oxygen by means of in-stream aeration. One mechanical aerator was put into operation in the summer of 1970, others added in 1971 and 1972. These devices work like a giant egg beater, stirring up the water and exposing it to air. In this way oxygen is mixed with the water in sufficient quantities to maintain fish and other aquatic life as well as to aid in the process of chemical and biological decomposition of waste materials.

5. Treat non-aqueous liquid wastes. The collection of gasoline, oil, paints, solvents (residual liquid wastes) and their disposal by appropriate treatment is being initiated by private investors with Miami Conservancy guidance in the Franklin Environmental Complex.

The following description of water-related problems of the region by Dr. Jane L. Forsyth, Professor of Geology, Bowling Green State University, relates water problems to the underlying rock strata:

"Southwest Ohio has long been famous for the unusual abundance and preservation of the fossils found in the rocks. It is also famous because this is the only area in Ohio in which pre-Illinoian (Kansan) till is found. This area is now famous for a far less attractive reason—the shale bedrock is so completely impermeable and so soft that extremely serious problems of environmental geology result.

"The first problem resulting from the presence of the shale is that no water can be obtained from the bedrock; drilling on uplands results only in 'dry holes.' Water comes, in this area, from cisterns, from nearby valleys (piped from the river or from wells in gravel deposits in the valleys), or from municipal supplies. Anyone who builds a beautiful country home on the uplands in this area before solving the problem of a source of water may end up with a water-less home.

"The second problem is concerned with septic tanks, which simply do not work in such 'tight,' impermeable shale; that is, the effluent cannot seep away from the septic tank through the ground as it is supposed to do. Leach beds help to move the effluent a little way and do improve its quality, but then the unattractive, still-impure sewage water must flow into ditches and creeks, contaminating them. Tying into municipal sewage-treatment systems alleviates much of this problem, but long sets of sewer pipes are very expensive.

"Another characteristic of this southwest Ohio shale is its fineness, so that, wherever the vegetation has been destroyed, as at the site of a new development, erosion and siltation not only create an unattractive landscape, but are serious problems. These problems are compounded by the fact that the sediments tend to be washed into sewers and on into the sewage-treatment plant, where the mud creates real and expensive difficulties.

"In addition, as the shale erodes, the banks become unstable and slide. A sliding bank is unattractive, but many of the slide masses occur under houses, the motion being encouraged by the weight of the house and any water used for watering the lawn, so the houses may be carried down, too. These shales are among the most unstable in the state, and well known for creating such engineering disasters.

"One other environmental problem in southwest Ohio is damaging flooding as a result of the use of flood plains in many of the urban areas. Along the Ohio River in particular, bad floods have caused extensive damage in the past. Urban Cincinnati is already moving to create parks and parking areas on the flood plain, but in many other areas, flooding still continues to cause great damage because of the flood-damageable buildings constructed on the flood plain.

"Southwest Ohio, therefore, is very famous—for its fine fossils, for its most ancient till, and also, in terms of environmental geology, for its waterless uplands, its bad erosion problems, its damaging floods, and its impressive landslides (with or without buildings on them)."

The improvement of streams and rivers throughout the region will be achieved only with citizen support for water quality management. Municipalities must improve their treatment of wastes before releasing them into the waters. Each citizen should realize that the consequence of doing nothing is disastrous and far more costly than intelligent corrective action. Industry is making great strides in cleansing its outflows. The Ohio Environmental Protection Agency is equitably enforcing the laws. With the help of bodies like the Conservancy Districts and a generation of informed students, the job will be done.

An environmental situation in regard to concentration of recreation facilities and their impact on normal living processes is frequently observed in the northern part of the region, primarily Logan, Shelby and Mercer counties. Lake Loramie, Indian Lake and Grand Lake St. Mary's encompass considerable acreage and provide swimming, fishing, boating and camping for thousands of people each year. The area happens to have, also, a high elevation which is scenic and proves to be desirable for resident camps and skiing. Limestone caverns underlie this section and the history of the area proves to be an attractive feature. A study of the effects of the recreational attractions from the standpoint of litter, water and air quality, land use and resource management indicates that evaluation of present activities and future planning would be advantageous to the residents.

ARMCO STEEL PLANT

Location: Southeastern section of Middletown, Butler County.

Production of iron and steel has been a major industry in Ohio from the early 1800's. Growth was steady in several parts of the state until, by 1948, Ohio ranked second in production of raw steel, in blast furnace capacity and hot-rolled output. Only Pennsylvania outranked Ohio.

The blast furnace is used to convert the raw material into molten iron. The molten iron, plus a quantity of steel scrap, is then transferred to other furnaces to be refined into steel. The most common steelmaking furnaces are the open hearth, a process developed in 1861 which still accounts for about 40% of the steel made in this country; the basic oxygen process, a technique developed in Austria just after World War II, which now accounts for more than 50% of the steel produced; and the electric furnace, first introduced to the United States about 1906, which refines the remaining 10% of this country's 150 million-plus tons of steel.

The iron and steel industry in Ohio began with local ores smelted by means of charcoal heat in relatively large stone furnaces. The first one may have been fired in 1802, and the last one closed during World War I. The largest concentration was in southeastern Ohio's Hanging Rock district. The iron ore came from Pennsylvanian age rock strata three to 12 inches thick, and local limestone was used as the flux. The quantities of wood which needed to be cut to operate the furnaces were so great that it was necessary to have from 7,000 to 10,000 acres of furnace woodland to guarantee operation. Large numbers of local men were involved in the processing of iron. A well-equipped hot blast charcoal furnace, employing 20 to 40 men, made approximately 3,000 tons of iron a year. As many or more men than fired the furnaces were required to cut the wood, a winter month activity. Charcoal burning and transportation were contracted also by local people. Iron was sold to the fabricators up and down the Ohio River, especially to Cincinnati and Pittsburgh.

The industry developed in the Mahoning Valley as well as in the southeastern counties of Ohio. The old Hopewell Furnace on Yellow Creek near Youngstown ushered in an aspect of pioneer economy which became the basis for the most important industry in the region by the end of the century. (A. J. Wright, *Economic Geography of Ohio*, 1957, p. 132) Coal was first used in combination with wood, but the use of coal in iron furnaces was minor because of the excellence of iron made with charcoal, together with the abundance of wood for its processing.

When iron ore became plentiful in Michigan and Minnesota after the Civil War, and ore shipment by boat became feasible, the situation changed. Plants were built in the major cities in northeastern Ohio because of the accessibility of coal.

One of the steel-making giants that contributed much to Ohio's industrial stature had its start at the turn of the century in southwestern Ohio.

In 1900 a small steel fabricating plant was moved from Cincinnati to begin operation at Middletown. This plant was destined to become Armco Steel, a fully integrated steelmaking operation, beginning with the raw material to the finished product, and one of the most modern in the world.

Energy requirements are such that it became practicable to procure company mines. Low sulphur, low ash West Virginia coal came into use. The coal is reduced to coke with a gas by-product. The hydrogen sulphate is removed by passing through a solution of sodium carbonate; the resulting ammonium sulphate is sold as fertilizer. Light oils are extracted, some 50,000 gallons a week, and sold also.

Another necessary ingredient in the blast furnace mix is limestone. Armco early established its own quarry at Piqua, Ohio, which still supplies this product. Pellets of taconite ore and scrap iron, limestone and coke are constantly fed into the top of the blast furnace. A hot blast of air, heated to 2000 F. in stoves adjacent to the furnace, is injected near the bottom of the furnace. The coke burns, releasing gases which change the iron oxide pellets into molten metallic iron. This falls to the bottom of the furnace where the molten iron is "tapped" into "torpedo" cars, where it can be maintained in the molten state up to 24 hours. The hot gas rises to the scrubbers where 99.6% of the particulate matter is removed, and is then released through tall stacks. The limestone combines with silica and other impurities in the ore.

Tremendous quantities of water are used for cooling and cleaning the gases, 8000 gallons a minute for each. The cooling water goes to cooling towers to be recirculated. The gas water passes through a thickener to remove particulate matter, then drains into a sludge basin.

After the molten iron and scrap have been refined into steel, the molten metal is poured into giant, refractory-lined ladles. Cranes carry the ladles either to the "teeming isle," where the molten steel is poured into ingot molds and allowed to harden, or to a continuous caster, where the steel can be cast into a semi-finished shape such as a slab or billet. Continuous casting of steel is one of the newer technological innovations of the industry, but one large unit is in operation at Middletown.

The ingots produced by this process then go to the hot rolling mill complex, where they are reheated to 2400 F., rolled into slabs, stored and cooled. Later they are reheated again and rolled into coils; then to the "picklers" (a solution of hydrochloric acid)

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where surface rust and other impurities are removed. Other mills then cold-roll the steel to give it a dense, smooth surface. An annealing (softening) process of heating and cooling follows and then the rolled up steel is ready to store or ship. The bulk of the material from this plant is sent to Hamilton Fisher Body, to Detroit and to other appliance and steel building centers.

Visitors generally get the opportunity to see the blast furnaces which convert raw materials to molten iron, and the steelmaking furnaces which refine the iron and steel scrap to steel. A visitors' walkway permits a relatively close look at the conversion of giant ingots of steel into a long, flat strip, which then is rolled into a coil. Because of the heat and the massive equipment involved, safety rules are rigidly enforced.

A tour of the premises also affords a look at the huge taconite piles (iron ore), the conveyors for feeding the material into the furnaces, the cooling towers and settling basin. Railroads, which make a valuable contribution to the industry bringing in the coal, limestone and ore, taking away the finished steel and by-products, are very much in evidence. Trucks, too, are extensively used.

One of the outstanding features of this large industrial complex is the variety and scope of its air and water pollution control facilities. More than $50,000,000 has been spent in recent years on environmental quality, and the Middletown Works has been the recipient of awards from the Ohio Society of Professional Engineers, the American Society of Civil Engineers, and the Sports Foundation.

Armco will complete a $20,000,000 solid waste recycling facility here in late 1974 which will convert more than 800,000 tons of waste materials annually into a reusable product for its blast furnaces. In addition, it has a long-term agreement to re-cycle the ferrous wastes recovered by the City of Franklin in its municipal waste recycling effort.

The Armco Information Center opened its doors to visitors in December, 1969, on the 70th birthday of the organization. The center was established to preserve relics from the past as well as to present a complete picture of the extensive operations of Armco today.

The first level of the center is devoted to Armco's history. In a 20-seat theater one can see a film presentation of the past. There are slide shows, slowly rotating cylinders and static exhibits to attract the eye and tell the story.

The second level has areas reserved for each operating division. Together, both floors graphically explain what goes on in the steel making process, making a trip through the plant more easily understood.

The plant management restricts visitors to the plant to persons over 12 years of age. This is an excellent study for physics, chemistry and earth science classes. To arrange a visit contact: Director of Public Relations, Armco Steel Company, 24 North Main Street, Middletown, Ohio 45042, Phone: (513) 425-2888.

The Information Center is open 8 a.m. to 5 p.m. weekdays. It may be opened at other times by special arrangements. There are no age restrictions. Contact: Receptionist, Information Center, Armco Steel Corporation, Curtis and Forest Streets, Middletown, Ohio 45042, Phone: (513) 425-5556.

Armco Steel

CINCINNATI NATURE CENTER

Location: Seven miles southwest of Milford, Ohio, in Clermont County between Perintown on US 50 and Glen Este on SR 32.

The Cincinnati Nature Center is a public non-profit educational institution dedicated to developing ecological awareness, understanding, and concern through education of youth and adults.

The CNC Association, operated by a board of trustees, oversees two facilities in Clermont County: the CNC on Tealtown Road and Long Branch Farm ten miles north of CNC.

The nucleus of the Tealtown center was the Carl Krippendorf estate of about 180 acres which became available for development as a nature center in 1966 under the visionary leadership of Stanley M. Rowe, Sr., a prominent retired Cincinnati businessman. Today the CNC has grown to 680 acres encompassing forest, fields, a stream, a lake, and five ponds. Approximately four miles of trails are available and other trails are planned for the more remote areas.

The contemporary Rowe Interpretive Center contains offices, bookstores, library, and a large flexible classroom-meeting room for school classes, members' programs, and exhibits.

The Carl Krippendorf Lodge, the original residence of distinctive 1900 architectural charm, offers special meeting rooms for small adult groups. The original Krippendorf farm barn and the extensive limestone steps and bridges constructed over the past 70 years add historical perspective to the use of the land.

A gift of Mrs. Neil H. McElroy and the late Mr. McElroy, Long Branch Farm consists of 535 acres, two creeks, permanent pastures, cropland, feedlot, silo, barns, houses, pens, and a show barn. The herd of 200 head of registered Angus is managed as breeding stock.

This farm will be run as a self-supported educational farm division of the Cincinnati Nature Center to offer students an opportunity to learn more about the source of man's foods and the complexities of food demand and production in the outdoor laboratory of an operating stock farm.

The streams cutting through CNC and Long Branch have created unique land forms offering students and professionals a rich picture of the geological changes that have taken place in southwestern Ohio over the past 450,000,000 years.

The sedimentary strata exposed in the stream valleys are a part of the oldest bedrock in the State of Ohio, laid down by warm, shallow seas that covered the area during the late Ordovician Period. Limestone layers from two to five inches thick contain an extensive collection of fossils. The shale layers, breaking down easily, have contributed to the formation of several attractive waterfalls in the streams. Occasional formations of ripple marks and wave action may be visible.

After eons of erosion, sedimentation, deposition and again erosion, this area was subjected to other enormous land changes during the ice ages. The Kansan glacier (1,200,000-1,060,000 years before the present) and the Illinoian (400,000 before the present) covered the area of this study and the Wisconsin (110,000-20,000 before the present) stopped just north.

The CNC and Long Branch sit upon the remains of the weathered Illinoian till plain. Occasional glacial boulders of igneous or metamorphic rock uncovered in the fields and frequent glacial pebbles in the streams dramatize the passage of the glaciers in southwestern Ohio.

On the hillsides much of the Illinoian till has been carried away by drainage streams to expose the late Ordovician group — the Maysville shales. Here the drier conditions of the soil support a somewhat different vegetation than the poorly-drained upland till plain.

Although the streams of both Long Branch Farm and CNC drain eventually into the Little Miami River, only from the Lookout Trail off Tealtown Road can one see the extensive valley of the East Fork of the Little Miami where waters from the ancestral Ohio were ponded as the Illinoian Glacier advanced south. Terraces remaining from this era and still visible along the East Fork support farm barns and houses and the Norfolk and Western Railroad tracks. One hillside accessible from a CNC trail consists of conglomerate rock associated also with the Illinoian glacier.

Although the early vegetation of the CNC and Long Branch areas was similar, as indicated on the Original Vegetation Map, man's use of the lands has resulted in a somewhat differing cover today.

The CNC is indebted to Carl Krippendorf for having been moved early in life by a "land ethic" to preserve the extensive forested slopes and upland that were to become the present nature center. This forest is mainly a mixed mesophytic association with beech, sugar maple, basswood, tuliptree, red oak, hickories, white ash, black cherry with occasional chinquapin oak, sour gum, white oak, bur oak, red elm, buckeye and walnut. In poorly drained areas pin oaks thrive. The understory consists mainly of spice bush, hop hornbeam, blue beech or ironwood, dogwood, red bud, wahoo, and pawpaw.

The floor of the forest is covered in spring with the typical wildflowers occurring in such forests. But in addition Mr. Krippendorf introduced near his residence other flower bulbs that have thrived over the years and provide some form of bloom almost every month in the year. In this horticulture area he introduced also flowering shrubs that contribute to the floral display. A restoration of his Herbwall and the fern valley provide study areas of interest to gardeners and students. Other important study areas consist of old pastures now growing up in elm, maple, cherry, ash, and vines; fields mown in the past but now becoming examples of field succession; several crop fields; and an eleven-acre field demonstrating controlled and uncontrolled watershed farming practices – strip and row cropping, waterways, terracing, bird food and shelter. These crop fields display plantings of soybeans, corn, millet, sorghum, alfalfa, clover.

Long Branch Farm also retains a portion of the early forest cover but in this case it has been grazed. The large permanent pasture will remain and the croplands will continue to be planted in corn and soybeans. Because of the nature of the educational program at Long Branch, the emphasis will not be on plant or animal community relationships but rather on the function of a farm and modern beef cattle in today's environment.

The diversified nature of the plant communities at the CNC naturally produces a broad spectrum of animal life. The forest community is abundant in its bird population from the leaf-covered floor to the pointed buds of the tallest beech. Owls, hawks, pileated woodpeckers, and turkey vultures offer the casual birder some real success when the many warblers only confuse.

The five-acre lake supports a number of mallards, wood ducks, and Canada geese as full-time residents and attracts migrating waterfowl, often of species unusual to the area. The ponds provide delight to the young students in the spring as turtles, tadpoles, frogs and salamanders vie for food and territory. Here, too, in-depth studies of other pond life reveal the diversity of organisms even in the smallest pond. Comparison of pond and stream animals is conveniently possible within an hour's visit.

Although mammals are not usually visible, evidences of an extensive population may be frequently observed at CNC. Homes of the woodchuck, tracks of a fox, droppings of a rabbit, a raw piece of meat stashed by a weasel, muskrat tunnels and lodges, traces of deer, raccoon, possum, attest to the fact that the CNC is a wildlife sanctuary.

Perhaps the most productive population, educationally speaking, are the insects of field and forest and their larvae under logs and in the water. Here young students can observe an animal in its home, or in a temporary study cage, almost every month in the year, learning of the interrelationships between organisms and the environment.

To implement an educational program that reaches as many as 7,500 children a year, plus supporting membership, youth and adult groups, teachers, and the general public, the staff is augmented by a group of trained volunteers. They enable the four-member naturalist staff of CNC to divide large classes into small groups of ten or less for land study. Other volunteers guide garden clubs and other adult and youth groups. The bookstore and library are also staffed by volunteers, many of whom are on the planning committee for these services. Several special horticulture projects are sponsored by volunteers who do most of the planting. Long Branch will also have a corps of volunteers when operating full-time as an educational facility.

School classes accompanied by teachers and some parents come to CNC for a program lasting from one hour to approximately four, depending upon previous arrangements. Some classes may come more than once a year in which case the teachers attend a staff-directed workshop for preparation and coordination. Teaching techniques encourage experiential learning, scientific observation and recording, conceptual approach, "discovery" method. Ages vary from first grade through college.

The CNC staff conducts workshops for teachers in environmental education with emphasis on teaching techniques for the outdoor classroom. Workshops may be held at CNC or on a school site. Teachers who have taken CNC workshops may lead their own classes at the CNC if they have demonstrated the necessary skills to conduct a class in the outdoors, and are approved by the CNC educational staff.

Fee for each child in a class or youth group is 50 cents. Fee for teacher workshop is $1 per teacher per hour of workshop. Adult groups pay a fee of from $15 to $25 depending upon the facilities needed for the meeting.

All groups must make reservations ahead of time, preferably six months to a year in advance. All comprehensive school program reservations (two days for each class plus two teacher workshops) are completed before October 1st for spring and before April 1st for fall and winter. Other single school groups must call on those dates to arrange reservations for the following season. No more than sixty children may be accommodated at any one time.

Long Branch Farm will operate on an experimental basis in Fall 1973 and Spring 1974. It will be open to organized groups led by CNC staff only. Contact Director, Cincinnati Nature Center, 4949 Tealtown Road, Milford, Ohio 45150, (513) 831-1711.

DAYTON POWER AND LIGHT COMPANY: HUTCHINGS STATION

Location: At 9200 Chatauqua Road, two miles south of Miamisburg on the Great Miami River.

Electricity has become the most important service for the technological age in which we live. In most places we depend upon it to pump our water. Even if we have a gas or oil furnace we must have electricity to man the automatic controls. We close our windows and obscure the light, necessitating electrical devices to cool, heat, humidify or dehumidify and filter the air we breathe, and furnish us light to carry on our activities. Electrical equipment makes life easier for the housewife, the industrial worker, the farmer, the woodman, the carpenter. It saves time for social, civic and cultural activities former generations found impossible to perform.

This important service to mankind is made available by means of converting other kinds of energy into electricity — coal, water, geothermal heat, nuclear fission and solar energy. In each source an environmental trade-off is exacted. There is no better way for students to appreciate the product of these trade-offs and to evaluate them environmentally than to see the complicated process and the fuel requirements in generating electricity. A field trip to the O. H. Hutchings Generating Plant will make this realization vivid.

The O. H. Hutchings Station is located on the flood plain of the Great Miami River. It uses river water for cooling and returns it 15 degrees warmer. A small diversion channel has been constructed from the river to the plant. An average generating station such as Hutchings Station must have 400 million gallons of water a day just for condensing the steam returning from the turbines. The water which is turned into super-heated steam by means of raging furnaces is obtained from the groundwater stored in the glacial sand and gravel deposits filling a buried pre-glacial valley. This water goes through a purifying process which extracts all solid matter.

A great storage yard of coal lies beyond the plant. This station procures its coal from West Virginia and eastern Kentucky. It is a high grade bituminous coal, low in sulphur (.75%) and ash (10%). Two thousand tons or 30 railcar loads are consumed each day.

The coal is lifted on inclined belts to a crusher and finally to pulverizers. Here it becomes so fine that it feels like black talcum powder. This powder is mixed with preheated air and blown into the furnace where it ignites instantly and releases its heat energy.

Heat in the furnace boils water which circulates in tubes lining the inside of the furnace wall. Steam is separated from the water in a steamdrum, then flows into a network of tubes where it is super-heated to 1000 degrees F.

The steam's energy is converted into electrical energy by passing through the blades of a turbine, producing tremendous force. This force turns a shaft or rotor and its associated magnetic lines of force. These are passed over the coils of a stator, producing the electrical potential called voltage. The speed with which the outer edges of the turbine wheel travel may exceed 800 miles an hour — 100 miles an hour faster than sound travels in air.

After the steam has accomplished its task of turning the turbine blades, it moves down into a condenser where cool circulating water drawn from the river makes the steam condense to water again. The water from the condensed steam is recycled, returning to start another trip through the furnace and turbines. The cooling water is used once and returned to the stream.

The O. H. Hutchings Station has six generators which give this station a total rated capacity of 360,000 kilowatts.

The gases created by the rapid oxidizing of the coal pass into the chimneys or great stacks which rise hundreds of feet into the sky. Six new electrostatic precipitators are now in operation at the O. H. Hutchings Station, a $6 million project begun in 1971 and now complete. No visible emission can be seen from the chimneys of these units. They are called hot precipitators because the gases pass through the unit at a temperature of 650 degrees F. The temperature makes the collection of the ash more effective. The stacks remove 99.5 percent of the ash from the flue gases. The ash is collected and stored until it is eventually disposed of in abandoned gravel pits. It is too expensive to return it to the mines.

Power transformers with cooling fans, one for each unit, are located beside the main building. These step up the voltage to 69,000 volts for efficient transmission.

Networks of high tension lines carry the energy to service areas. The Hutchings plant has a hook-up with the Cincinnati Gas and Electric Company lines to guarantee continuous service to all consumers. In fact, the Dayton Power and Light Company is a member of the ECAR (East Central Area Reliability Coordination Agreement), a regional energy system for providing continuing service for future needs of an extensive area in the northeastern states. An emergency, rapid starting generating unit operating on diesel fuel is an auxiliary device.

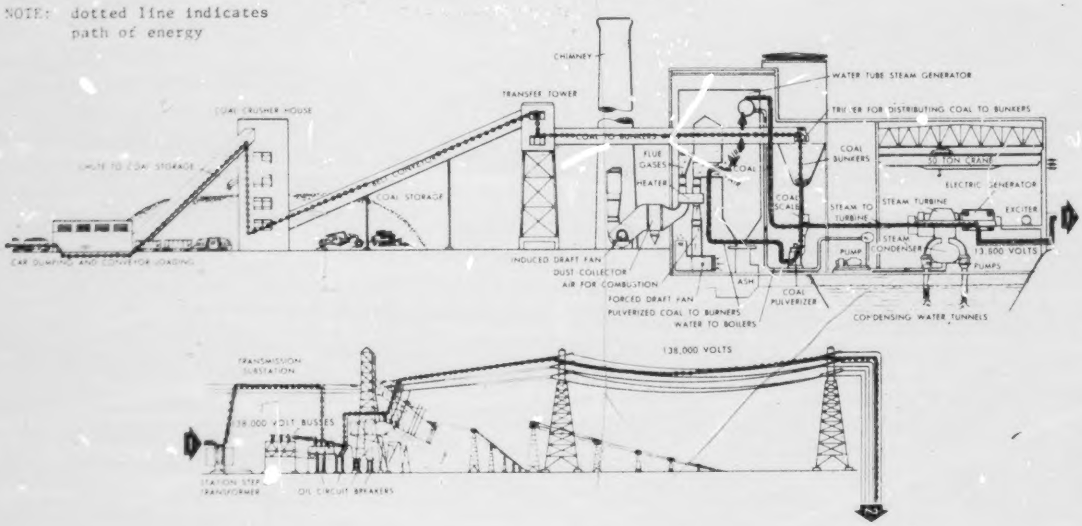
The Dayton Power and Light Company is moving to comply with the latest federal and state requirements for air and water quality. The financial costs are great for all environmental improvements and will eventually mean higher costs for the consumer. To comply with the applicable air quality standards, the company is either replacing or modifying dust collection systems at its three generating stations . . . an $11 million expenditure at J. M. Stuart Station, $8 million at F. M. Tait Station, and $6 million at O. H. Hutchings Station. To comply with water quality standards, a closed-cycle cooling tower has been constructed at J. M. Stuart Station at a cost of about $7 million.

Other tours offered by Dayton Power and Light are of the Service Building at 1900 South Broadway, Dayton, a museum with early electric equipment, gas and electric meter shops, electric testing and customer service. This can be a valuable tour for basic understanding for grade school students and older. A tour of the company's Modern Lighting Center at the Gas and Electric Building, 25 North Main Street, Dayton, is recommended for high school students and adults.

For trip preparation the company has prepared three films: *The Principles of Electricity*, which explains the basic laws; twenty minutes. It is recommended for elementary as well as high school students; *AC-DC Generation*, time twenty minutes, produced by General Electric and describing scientific principles for generating two kinds of current; for high school students; and *To Be Continued*, a fascinating story of the electric industry for high school and adult groups. It is 28 minutes in length.

Students must be 14 years of age or older for trips to the generating plants. Three weeks' advance planning with the company is required. Contact, for tours, films, or talks: The Dayton Power and Light Company, Public Affairs Department, 25 North Main Street, Dayton, Ohio 45401, Phone: (513) 222-0441. Ext. 7420.

ELECTRIC GENERATING & TRANSMITTING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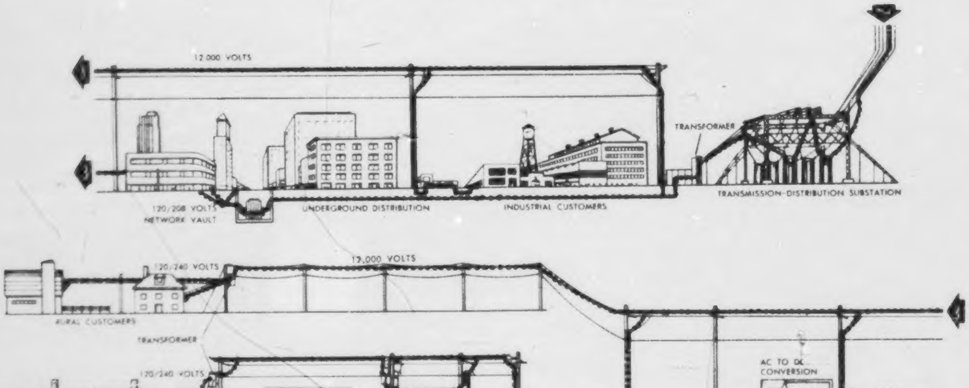
CHIMNEY
TRANSFER TOWER
COAL CRUSHER HOUSE
CHUTE TO COAL STORAGE
BELT CONVEYOR
COAL STORAGE
CAR DUMPING AND CONVEYOR LOADING
COAL TO BUNKERS
FLUE GASES
HEATER
COAL
AIR
WATER TUBE STEAM GENERATOR
TRIPPER FOR DISTRIBUTING COAL TO BUNKERS
COAL BUNKERS
50 TON CRANE
ELECTRIC GENERATOR
STEAM TURBINE
EXCITER
COAL SCALE
STEAM TO TURBINE
STEAM CONDENSER
PUMP
13,800 VOLTS
PUMPS
INDUCED DRAFT FAN
DUST COLLECTOR
AIR FOR COMBUSTION
FORCED DRAFT FAN
PULVERIZED COAL TO BURNERS
WATER TO BOILERS
ASH
COAL PULVERIZER
CONDENSING WATER TUNNELS
1
TRANSMISSION SUBSTATION
138,000 VOLT BUSSES
138,000 VOLTS
STATION STEP-UP TRANSFORMER
OIL CIRCUIT BREAKERS
2

ELECTRIC CONSUMERS (USERS)


2
12,000 VOLTS
3
3
TRANSFORMER
120/208 VOLTS NETWORK VAULT
UNDERGROUND DISTRIBUTION
INDUSTRIAL CUSTOMERS
TRANSMISSION-DISTRIBUTION SUBSTATION
120/240 VOLTS
12,000 VOLTS
RURAL CUSTOMERS
4
TRANSFORMER
120/240 VOLTS
STORE
AC TO DC CONVERSION
600 VOLTS DC
4
RESIDENTIAL CUSTOMERS
COMMERCIAL CUSTOMERS
STREET LIGHTING
DISTRIBUTION SUBSTATION
RAILWAY SUBSTATION

FORT ANCIENT STATE MEMORIAL

Location: Fort Ancient State Memorial is located seven miles southeast of Lebanon on SR 350 in Warren County, Washington Township. The 696-acre memorial is situated on the east bank of the Little Miami River.

The purpose in suggesting this site for study is that it represents two pre-history cultures which may have yielded some influence upon the later development of Indian cultures, and in turn upon the European explorers and the New England settlers. These early cultures developed simple technologies to meet their needs and art forms to express their oneness with the natural world. The site remains a preserved natural area, a study of which, in itself, gives an appreciation of that part of the Ohio heritage.

The Fort Ancient earthworks are located on a rising bluff about 270 feet above the Little Miami River valley floor. The earthen walls of the fort follow the irregular edge of a hill that is practically isolated from the general upland area by deep ravines. The fort is bounded on the west by the steep slopes facing the Little Miami River, on the east and southeast by the ravine of Cowen Run, and on the north by the gully of Randall Run. These two streams, which flow directly to the river, have cut their deep but short valleys down through the overlying Illinoian glacial till into the interbedded shales and limestones of the Ordovician period. These are abundantly fossiliferous with brachiopods, bryozoa, horn corals and gastropods, making the banks along the streams good collecting areas.

The site reflects the influence of the deeply weathered Illinoian till soils developed from the glacial material left in place some 400,000 years ago.

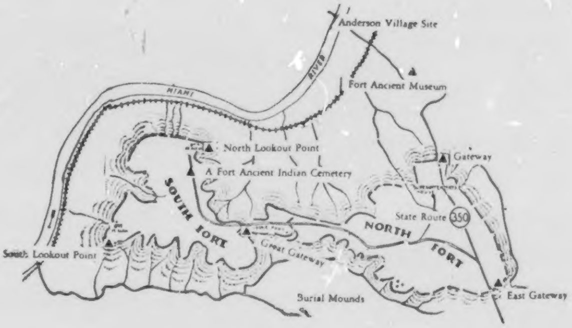
The original vegetation was mixed oak, beech and maple forest with much variety of species in the canopy and understory. The present vegetation pattern is similar, with many mature beeches, maple, tulip and oak. A great variety of wildflowers are found in protected ravines and hillsides. The bases of large trees serve to protect stands of flowers also. Throughout they are scattered but plentiful. Spring flowering reveals wild ginger, rue anemone, hepatica, blue cobash, cutleaf toothwort, spring beauty, May apple, bloodroot, Dutchman's breeches, squirrel corn, smooth yellow violet, Virginia bluebell and trout lily.

Salamanders and live land snails may be discovered in moist areas. Red-backed, lead-backed, and spotted salamanders are found under rocks and rotten tree stumps. Birds and small mammals typical of wooded habitats are abundant.

Two prehistoric Indian cultures inhabited the Fort Ancient earthworks and Anderson Village sites which together comprise the Fort Ancient State Memorial. The Hopewell Indians, who lived in Ohio between 300 B.C. and 600 A.D., built the Fort Ancient earthworks. Sometime between 1200 A.D. and 1630 A.D., the Fort Ancient Indians reoccupied the site and established two small villages.

The Hopewell Indians, using primitive tools of digging sticks and hoes made of shell, stone, and animal shoulder blades, scraped up earth from the surface and piled it along the edge of the bluff to form the walls of the enclosure. At a number of points slabs of limestone were placed within the walls for reinforcement. The "fort" which they built is in three sections: a North Fort, a Middle Fort, and a South Fort. Within each fort the Hopewell buried their dead beneath mounds and erected crescent shaped earth walls and laid stone pavements. These features formed the setting for religious and social ceremonies and were not used as fortifications for the protection of the inhabitants.

FORT ANCIENT STATE MEMORIAL



By uncovering the pottery, tools and ornaments found on the site, archaeologists have derived much knowledge concerning the Indians. They cultivated crops of corn, squash, beans, and tobacco. Trading was done extensively for items not found near the area. Jewelry was worn and fashioned with a high degree of artistry.

For unknown reasons, the highly developed Hopewell society declined and Fort Ancient was abandoned by its builders.

Long after the Hopewell culture had left the scene, the Fort Ancient Indians built, from 1000-1600 A.D., small villages in the South Fort and at the Anderson Village site in the valley. These people were farmers who supplemented their vegetable diet with game,

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fish, and wild plants. They were the first prehistoric men in the area to use the bow and arrow.

Although these people cultivated the soil and worked in bone, shell and stone, they never acquired the fine craftsmanship of the Hopewell Indians. No evidence of trade with white men has been found at this site. Once more the site was abandoned, this time shortly before the arrival of European explorers.

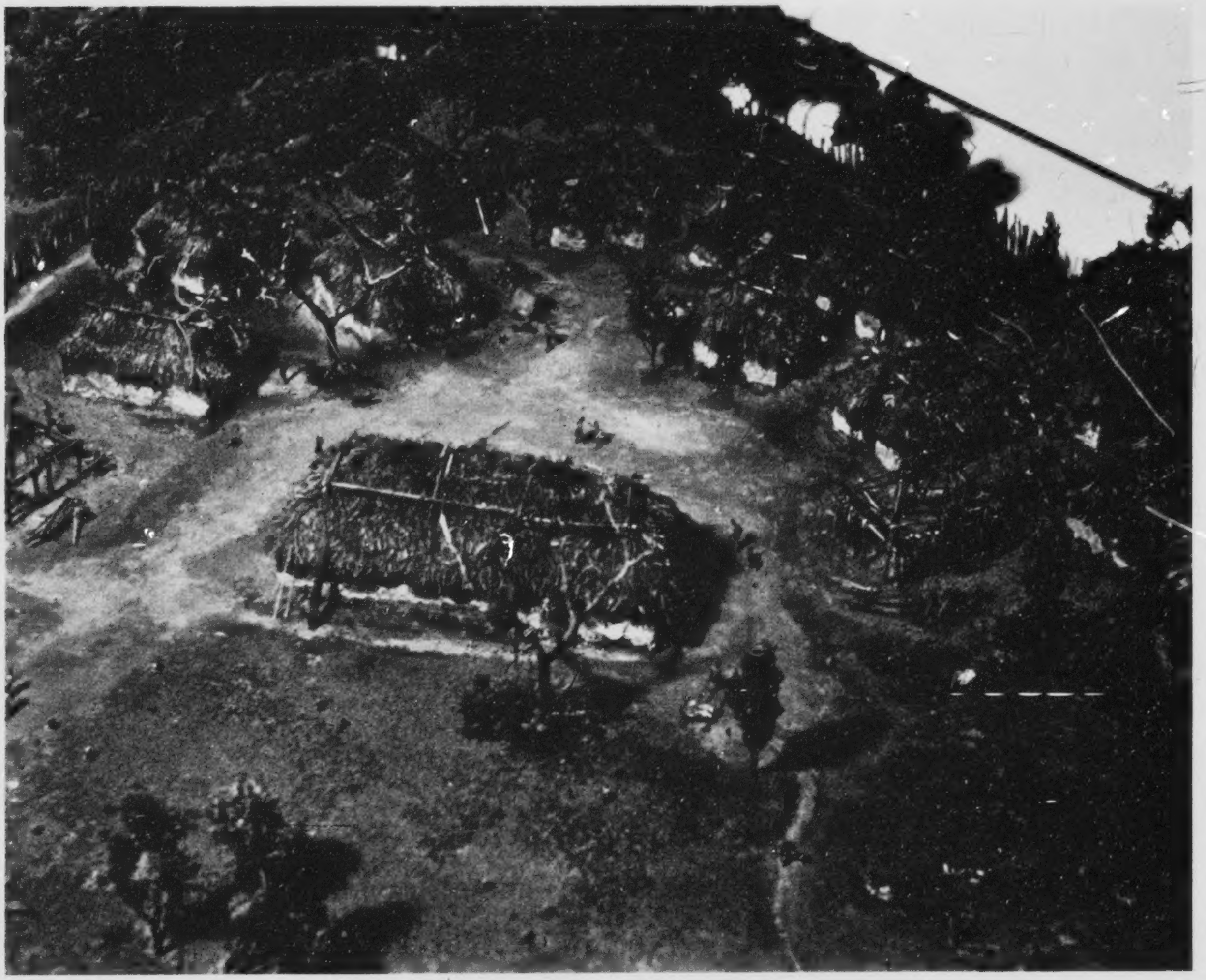
The preserve was created by a joint resolution of the legislature in 1891, making it Ohio's first state park. It was placed in the care and control of the Ohio Historical Society, where it has been ever since.

With the passage of time, the earthworks were subjected to some defacement by cultivation, by the explorations of untrained excavators and by natural erosion. However, steps have been taken to preserve and restore some of the damaged features. Natural erosion is being controlled.

Visitors to the area have access to parking space, shelter house, picnic tables, running water and rest rooms.

In the Fort Ancient Museum, opened late in 1967, are presented modern exhibits, models and life study groups of the two Indian cultures which inhabited the site. The Hopewell Indian displays portray primarily the ceremonial life and rituals which are connected with the large earthworks. The Fort Ancient Village model shows the probable life of these people as well as the construction of their living areas.

There is no charge for school groups to go in the museum. Contact: The Ohio Historical Society, I-71 and 17th Avenue, Columbus, Ohio 43211, Phone: (614) 469-2919.



Fort Ancient

FRANKLIN ENVIRONMENTAL CONTROL COMPLEX

Location: In Franklin; west of I-75, SR 123 to River Street, left on River Street to Farm Avenue, around house, across levee.

This site is a solid waste recycling plant designed to meet an immediate problem and to accommodate future needs. In 1967 the City of Franklin had used all its available landfill space. On the city council was an enterprising member who made paper mill equipment. He proposed a new concept for recycling waste into paper pulp which resulted in the construction of a new plant, financed by a grant from the Bureau of Solid Waste Management, U.S. Public Health Service, HEW (now an office of the Environmental Protection Agency). This 150-ton-per-day plant, the first of its kind in the world, handles all the current municipal waste material of Franklin and the surrounding communities of Carlisle, Springboro and Franklin Township. It is designed to process the area's projected tonnage through 1990 and is operated by Black Clawson Fibreclaim, Inc., under a management contract with the city.

The plant is the nucleus around which an environmental control complex has been built. Included in the complex is a regional waste water treatment plant, designed, built and operated by the Miami Conservancy District, Dayton. This part of the complex (A on chart) is the first of its kind in operation. It treats four-and-one-half million gallons of water per day. Modern in every way, it is controlled by a computer in Dayton. The purified effluent from this waste water plant is the water supply for processing and cooling in the solid waste plant; the sludge from the municipal clarifier is mixed with the non-recyclable organics of the solid waste plant and burned; and the waste water from the solid waste plant is treated in the waste water plant. Ash is used as a settling agent in the water plant's industrial clarifier and in a landfill project adjacent to the property.

A blending station where non-aqueous fluids such as cutting oils are stored, mixed and disposed of is another of the facilities within the complex (B on chart).

The country's first mechanized glass reclamation plant was constructed on the property in 1973. It sorts waste glass from the glass-rich residue of the solid waste material. After being broken up in a water solution, the glass pieces have a unique quality; the edges are not sharp. The glass is sorted into three colors — clear, green, and amber — by means of high density magnetism, air currents, screening, and optical sorting. The plant can sort four tons of glass daily, after which it is shipped to glass container plants for recycling. Blue and green glass are worth $12 a ton, white glass, $20 a ton.

Solid waste treatment (C on chart) consists of several steps:

Refuse delivery (1 on chart). Private contractors bring waste material to the site in trucks, collecting from residents who pay $36 per year for the service. The incoming refuse is weighed, dumped and then pushed into the conveyor pit by an end loader.

Wet pulping (2 on chart). The conveyor feeds the refuse into a wet pulping machine, mixing it with water and cutting it by a high speed rotor to form a slurry.

Metal recovery (3 on chart). Odd bits of metal, including tin cans and other non-pulpable and non-friable materials are ejected from the pulper, washed and conveyed to a magnetic separator.

Liquid cyclone — glass recovery (4 and 5 on chart). To remove the remaining inorganic material such as glass, ceramics, and aluminum, the slurry is pumped into a liquid cyclone where the heavier materials are selectively removed by centrifugal action. The objects from the cyclone are about 80 percent glass. The material is dried, screened, magnetically separated and classified into three fractions. The light fraction contains the aluminum and some of the heavier plastics; the heavy fraction contains the heavy, nonferrous metals; and the middle fraction is almost pure glass. This is sorted for re-use in glass container manufacture.

Fiber recovery (6 on chart). With the metals and glass removed, the slurry is pumped to the Fibreclaim for paper recycling. From 40 to 70 percent of the waste by weight is paper. Only the long paper fibers are useful, so they are mechanically separated from the remaining contaminants. Retained on a screen, the long fibers are dewatered, making them 40 to 50 percent dry. They are then delivered by screw conveyor to shipping containers to be shipped to a nearby paper company.

Non-recoverable organics-sewage sludge (7 on chart). The remaining organic rejects—rubber, textiles, yardwaste — are pumped into a storage tank from which they are fed into the "hydrasposal" department at a desired rate. The rejects are dewatered with a press, broken, discharged and fed into a fluid bed reactor for final disposal. Here the pieces are burned at 1400 to 1500 F. The exhaust gas is cleaned of particulate matter in a venturi scrubber and discharged as a clean, non-polluting, non-odorous white plume. Sludge from the adjoining sewage treatment plant is mixed with the organic material and burned in the reactor.

The most significant product pr[illegible] by the Franklin plant is the long fiber paper [illegible] However, there is a substantial heat value to th[illegible] material burned. Similar plants in other parts of the country convert this to steam and then into energy.

It appears that the Environmental Control Complex has been enthusiastically accepted by the community. Haulers are pleased, for they can get in and out very rapidly. Householders are satisfied, for the cost is reasonable. Eight thousand visitors from throughout the world—representatives from 17 foreign countries and 46 states—have toured the installation since it began operation in June 1971.

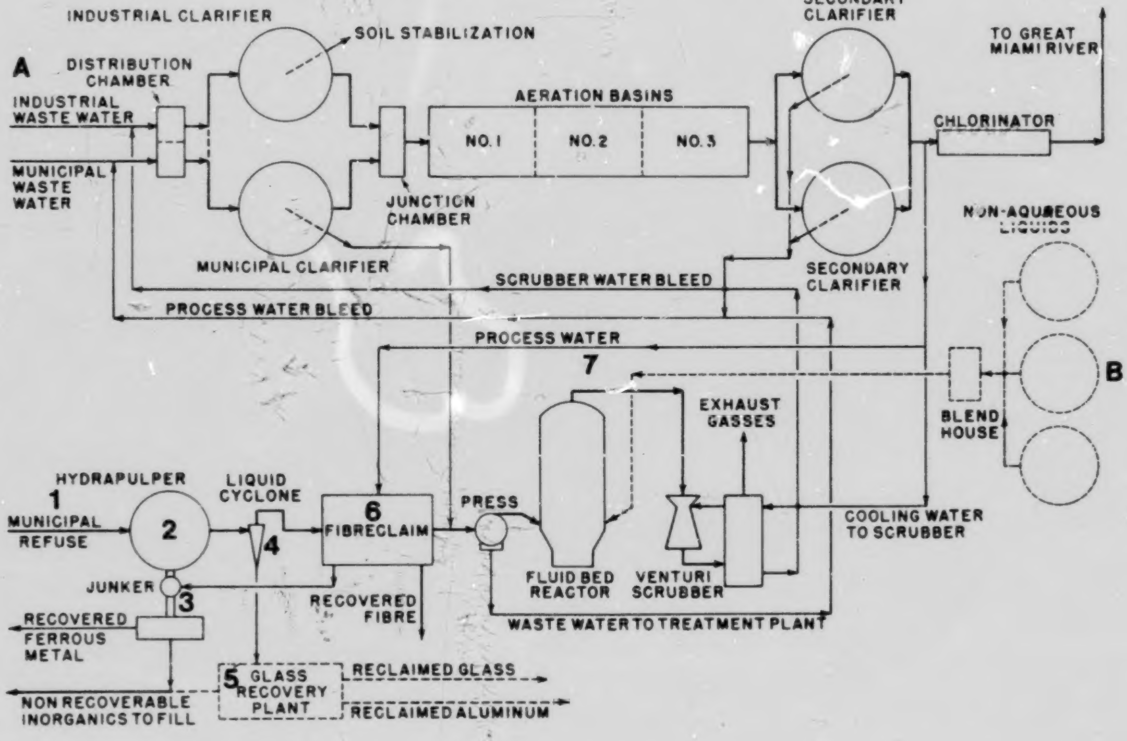
Expansion to a 24-hour-a-day program may materialize and increase internal efficiency as well as broaden the area of effective solid waste control.

Two moving pictures have been made which are excellent preparation for a visit to the complex.

Clean Tour USA, 15 minutes. Twelve copies for loan. Purchase price $100. Contact: Mrs. Marci Profitt, 605 Clark Street, Middletown, Ohio 45042 or City Manager, City Building, Franklin, Ohio 45005. *Cyglas*, Owens-Illinois, Inc., P.O. Box 1035, Toledo, Ohio 43651, (419) 242-6543.

Visits are restricted to high school classes only. Contact: City Manager, City Building, Franklin, Ohio 45005, Phone: (513) 746-9921 or Joe Baxter, Jr. P.E., Engineering and Marketing Consultant, Shartle Division, The Black Clawson Company, Middletown, Ohio 45052.

FRANKLIN ENVIRONMENTAL COMPLEX


A
INDUSTRIAL CLARIFIER
SOIL STABILIZATION
DISTRIBUTION CHAMBER
INDUSTRIAL WASTE WATER
MUNICIPAL WASTE WATER
AERATION BASINS
NO. 1
NO. 2
NO. 3
JUNCTION CHAMBER
MUNICIPAL CLARIFIER
SECONDARY CLARIFIER
SECONDARY CLARIFIER
TO GREAT MIAMI RIVER
CHLORINATOR
NON-AQUEOUS LIQUIDS
SCRUBBER WATER BLEED
PROCESS WATER BLEED
PROCESS WATER
7
B
BLEND HOUSE
EXHAUST GASSES
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1
MUNICIPAL REFUSE
2
LIQUID CYCLONE
4
6
FIBRECLAIM
PRESS
FLUID BED REACTOR
VENTURI SCRUBBER
COOLING WATER TO SCRUBBER
JUNKER
3
RECOVERED FIBRE
WASTE WATER TO TREATMENT PLANT
RECOVERED FERROUS METAL
5
GLASS RECOVERY PLANT
RECLAIMED GLASS
RECLAIMED ALUMINUM
NON RECOVERABLE INORGANICS TO FILL

GOOSE RUN VALLEY AND THE COURTS FARM

Location: Approximately ¾ mile south of Brown's Bridge on New Hope-White Oak Station Road between State Routes 32 and 68 in Brown County.

Goose Run Valley provides an excellent site for study of Ordovician fossils and a free-flowing, unpolluted stream. It is located on the farm of George Courts, a small diversified farm on which burley tobacco is presently the principal crop. While it is widely recognized that the use of tobacco is injurious to health, it has long been an important crop on Brown County farms and is included in this study for that reason.

The area was settled in the early 19th century. The farm was purchased by a Warren Lucas about 1913. At the time, the farm was badly eroded, and incapable of producing crops. Mr. Lucas undertook returning the farm to production, by manuring, erosion control, and establishing permanent pasture.

Mr. and Mrs. Courts obtained the farm in 1949. It has been operated as a tobacco-livestock farm since.

The Courts Farm is located in the White Oak Creek watershed. The land is gently rolling. The soil parent material is glacial till, overlying Ordovician limestone and shale. Water is abundant from a small stream, Goose Run, and a 32-foot well dug into the solid limestone.

Goose Run has cut deeply into the bedrock, exposing cliffs as high as 40 feet. The stream is free-flowing, has adequate oxygen, and flows over the limestone bedrock in a series of riffles and pools.

Fossils of the Ordovician period are abundant, particularly brachiopods, crinoidtems, cephalopods, and bryozoa. Trilobites and solitary corals are occasionally found. Because of the extensive exposures, several strata may be observed and traced for some distance.

During periods of high water, much silt is carried from farmland which lies upstream. However, the stream clears quickly upon return to normal flow.

Most areas of permanent pasture are bluegrass. Fence rows have occasional patches of blackberry, elderberry, and multiflora rose.

The Goose Run valley supports a diverse hardwood flora. Species present are hazelnut, elderberry, chinquapin oak, green, red, blue, and white ash, red oak, pin oak, white oak, chestnut oak, swamp white oak, pignut hickory, black locust, honey locust, black willow, sycamore, paw paw, winged sumac, sassafras, bitternut hickory, sugar maple, box elder, Ohio buckeye, American hornbeam, hop hornbeam, wild cherry, flowering dogwood, basswood, American beech, American elm, osage-orange, black walnut. Red cedar is abundant along the slopes bordering the streams. (Kenneth Cribbet, *A Guide to the Woody Plants of Goose Run*, 1972)

The entire area has been grazed for many years. However, the grazing has not been intensive and many of the more tolerant woodland herbaceous plants are present, providing wildflower display throughout the warm months.

Common farmland mammals are present, such as cottontail rabbit and wood chuck. Shrews, white footed mice, and meadow mice are abundant. In the woods, fox and grey squirrels are found. Chipmunks are common; raccoon, skunk, opossum, and mink occur along Goose Run.

Aquatic life in the stream itself includes abundant aquatic insects, fingernail clams, and gastropods. Fish species include various minnows such as creek chub, various shiners, and blunt nose minnows. Catfish are predominantly black bullheads and mad toms. Darters are common. The green sunfish is abundant.

Amphibians include the striped chorus frog and spring peeper, cricket frog, green frog, leopard frog, bull frog, woods frog, American toad, and tree frog. Salamanders include dusky, long-tailed, and two-lined. Snakes are abundant, and frequently encountered varieties are queen snake, hog-nosed snake, ring-neck snake, common water snake, and black king snake.

Snapping turtles are found in larger pools. Box turtles are common.

The birds are very diverse, including most of the common species. The pileated woodpecker nests in the area, and is occasionally seen.

Since 1949, this farm has provided the source of income for the Courts family. The principal cash crop is burley tobacco. This is supplemented by livestock production. The acreage of the farm is used as follows:

Tobacco, approximately one acre; corn, six acres; hay, five acres; permanent pasture, approximately 11 acres; grazed woodland, six acres, homesite, one acre — a total of 30 acres.

Livestock includes ten head of beef cattle, three brood sows, and 100 chickens. A large garden plot is cultivated for household use.

Tobacco production averages about 2,600 pounds to the acre. The leaf is generally of top quality, reflecting the care involved with production and housing of the crop. Tobacco involves more intensive care than most crops. This crop is unique in Ohio to a small region bordering the Ohio River. The only tobacco markets in the state are located at Ripley.

Unlike other crops, tobacco production is a year-round job, beginning with preparation of seed bed in very early spring. The crop is transplanted to the field in June, and cultivated several times to discourage weeds overtaking the slow-growing plants.

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When flower buds appear, they are removed to encourage leaf growth. An oil spray discourages the growth of suckers at the junction of leaf and stalk.

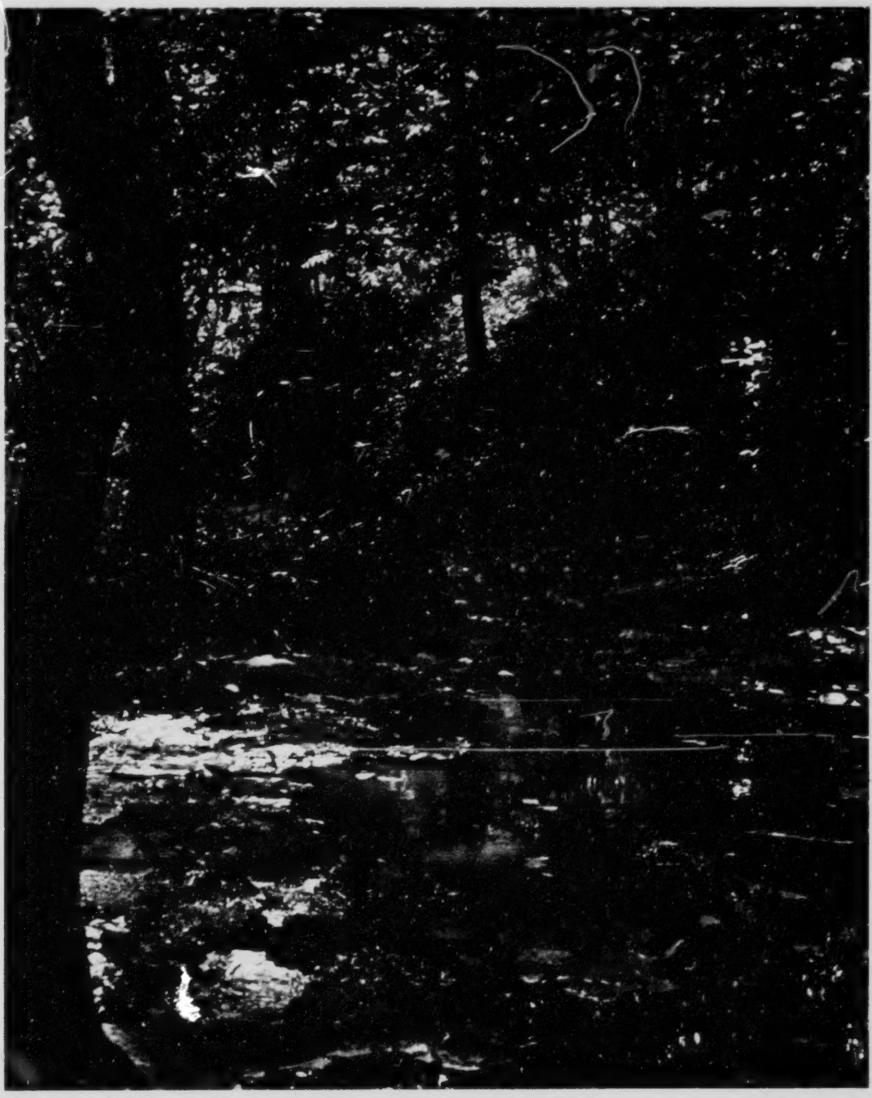
The tobacco ripens in early September. The stalks are cut, hung on sticks, and placed in barns or sheds for curing. The curing operation is very critical, and good ventilation must be provided. The tobacco cures in about eight weeks, when it is taken from the barn and "stripped," that is, removed from the stalks and graded. It is then transported to tobacco markets in Ripley, Ohio, or neighboring Kentucky. The markets are generally open from late November to early February.

Crops of hay and corn are used on the farm for livestock feed. Although semi-retired, Mr. Courts is still actively operating the farm.

One remarkable feature of the Courts farm is that, although chemical fertilizers are used to supplement manure and cover crops, herbicides or insecticides have never been used. Although tobacco is susceptible to insect pests such as grasshoppers and sphinx moth larva, natural controls have been adequate.

Careful management has enabled Mr. Courts to maintain an adequate income from this farm, although it is only 30 acres in size. Today, the trend has been to more automated production and extensive equipment. The Courts farm far more closely resembles the small family farm of many years ago.

Only parking is provided. Limitations on visits are to be set by the Courtses. No collecting is permitted. Contact: Mr. & Mrs. George P. Courts, RR #2, Georgetown, Ohio 45121, Phone: (513) 444-2872.



Goose Run Valley

MONTGOMERY COUNTY JOINT VOCATIONAL SCHOOL

Location: Off I-70 on the northern edge of Montgomery County.

The purpose of the study is to describe an area which provides outdoor educational experience in farming practices, environmental education, forestry, and horticulture.

The site was a 200-acre farm and has some buildings remaining that are 125 years old. The property has a long history of productive agricultural use. As suburban Dayton extended northward, this farm was sold to a doctor, who, in turn, after a few years, sold the property to the board of education of the vocational school. In the four years since that time, two large school buildings have been constructed at a cost of seven and a half million dollars. A third, now under construction (Spring, 1973), will bring the capacity of the school to 2000 students. The school gives training to both girls and boys who wish to attend. They leave their own high schools their junior or senior year. On completion of a two-year program they receive a diploma from their high school and a certificate from the vocational school.

The farm lies in the glaciated part of Ohio on sloping to gently sloping terrain. Dolomite bedrock of Silurian age is found beneath the heavy, transported glacial till. The land is in the Miami River watershed near the headwaters of Wolf Creek, Little Bear Creek and Twin Creek. The soil is in the Crosby-Brookston group, poorly drained on the nearly level terrain.

Thirty acres of the farm are mature beech-maple forest. Ninety acres of tillable land are currently in agricultural production. The students actually plant, cultivate and harvest the corn, hay and wheat, thus developing skills and experience for doing farm work. Approximately ten acres along a stream are in various stages of plant succession.

The wildlife is typical of an agriculture community, consisting of quail, pheasant, rabbits, fox, ground hog, squirrel, raccoon, muskrat.

This area offers an excellent opportunity to study the soil with conservation practices in operation. These include farming the land at its capacity, sod water-ways in operation, one half-acre pond constructed, five acres of new pine forest, and the 30 acres of mature woodlot. All stages of ecological succession are readily observable; there is an improved nature trail one mile long, plus two miles of heavily wooded trail. One mile of flowing stream, with all types of freshwater life, is valuable for aquatic studies.

The school personnel welcome outside classes for field trips or more extended study programs. Almost any age or size group is acceptable. There is no outside restroom or eating facility except when school is in session. Student group leaders are available during the school session. Contact: Agriculture Supervisor, Montgomery County Joint Vocational School District, 6800 Hoke Road, Clayton, 45315, Phone: (513) 837-7781, ext. 52.

Montgomery County Joint Vocational School

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THE RIPLEY UNION WATER ASSOCIATION

Location: north of the Ohio River at Ripley, approximately 12 miles, extending west along US 52 to the Straight Creek Bridge.

This site provides a study in a local solution of the problem of a dependable rural water supply.

The water system is located in two very different geologic situations. The western extension of the water system is located entirely upon the Ohio River flood plain along US 52. The northern extension follows the Ripley-Day Hill Road seven miles. A branch extends along Pisgah Ridge Road to an auxiliary standpipe water tank. Another branch follows West-Henry Road to US 62-68.

This northern extension encompasses the very rough topography of the limestone and shale ridges bordering the Ohio River flood plain. These hills are the result of the erosion of the original surface by many small streams draining into Red Oak Creek and Straight Creek.

The ridges are characterized by fairly shallow soils and steep gradients except on ridge tops and stream flood plains. Much of the area is in second-growth timber and pasture land. Cultivation is primarily for tobacco, corn and soybeans.

Wells in this area drilled into the bedrock are unpredictable producers, usually yielding less than two gallons per minute. (*Water Inventory of the Ohio Brush, Eagle Straight and Whiteoak Creek Basins*, State of Ohio, Department of Natural Resources, Division of Water, Report No. 15, November 1960). Often, wells are unreliable in drought periods. Before construction of the water system, most homes and farms depended on cisterns and ponds, supplemented by water purchased and hauled by truck.

The area is part of the former Virginia Military Reservation. Permanent settlements existed at the end of the 18th century, concentrated along the Ohio River and major streams. Early agriculture production was primarily devoted to livestock and corn until the development of white burley tobacco about the time of the Civil War. Most of the area was cleared for agricultural purposes, including much steep land that should have been left timbered. As increased erosion took its toll, much previously cultivated hillside land has reverted to brush and woodland.

Increased water needs for domestic and livestock uses caused citizens to seek a cheap, dependable water supply. In the late 1960's, this encouraged the formation of the Ripley Union Water Association. Application was made to the Farmers Home Administration for a grant or loan. A loan was made, and construction of water mains was begun. The first lines were opened in 1969, and the entire system was operational by May 6, 1970. The original FHA loan was for approximately $350,000.00. This sum was adequate for initial construction.

The Ripley Union Water Association obtains its water from the Ripley municipal water system, where it is pumped from wells originating in the glacial outwash deposits beneath the Ohio River flood plain. The water costs 15¢ per 1,000 gallons. It is sold to local residents for $8.50 per 3,000 gallons. Until April 1, 1973, cost was $6.60 per 3,000 gallons. Increased charges were necessary to keep abreast of increased maintenance costs. A tap-in fee of $200 is charged new subscribers.

Present volume of the system averages approximately one million gallons per month. The system is limited by its supply contract to one and a half million gallons per month, so is operating at approximately two-thirds capacity.

Maintenance and water costs are the greatest expenses. Only one booster pump is operated, which elevates water to the Pisgah Ridge stand pipe tank. Pressure is maintained by gravity.

Construction of the system was made difficult by the nature of the topography. Generally, the water lines follow county roadways.

Subscribers include year-round residents, farms, and seasonal users — campers and residents of summer homes along the Ohio River. Presence of the water system encourages increased residential, agricultural, recreational, and industrial development.

The environmental impact of the system has probably been negligible since original construction. Because water use from wells and ponds has been reduced, ground water supplies may be favorably affected.

An alternative to the system might have been an upground reservoir-well system, stream impoundment, or increased well development. Because of the readily available water from Ripley, the development of the system was probably the most economical alternative available.

Local residents seem very pleased with their association, and consider it a successful solution to a problem which is common to many of Ohio's rural communities. Adequate water has been provided at minimal cost and minimal alteration of the natural environment.

For permission to visit, contact: Mr. Andrew Pfeffer, RR #1, Ripley, Ohio 45167, Phone: (513) 392-4041.

UPPER VALLEY MALL

Location: Upper Valley Pike and SR 41, Clark County.

The shopping mall is an important part of the recent experience of the American people. Centralized shopping facilities and the growth of suburbia have had an impact on the growth of entire metropolitan regions. The automobile has necessarily had a part in the preference for shopping centers with convenient parking facilities. The American consumer has also shown a preference for enclosed climate-controlled malls. A number of attractive shops around a mall concourse have provided a type of town center featuring such things as boat and camper shows, fund-raising activities, and children's entertainment.

The Upper Valley Mall is located northwest of Springfield and serves approximately 400,000 people from all or part of four counties—Clark, Greene, Champaign, and Montgomery. Until 1965 the mall site was in a predominantly agricultural area of the Mad River Valley. The process of development, including the acquisition of approximately 80 acres and the procedures for rezoning and for providing services necessary for a facility with 25 acres under one roof, began at about this time. Cooperation of public agencies to facilitate development, in anticipation of future residential, commercial, and industrial growth in the area, can be seen through several examples. A substation with enough power to serve 30,000 people was constructed during the latter 1960's. Road improvements to widen portions of SR 41 and to improve Upper Valley Pike amounted to roughly $130,000. Water and sewage services for the mall are city-based, giving some evidence of the city of Springfield's anticipation of growth in the area; annexation of the area in the mall vicinity is currently being discussed.

The mall itself was opened in August of 1971, approximately 18 months after the beginning of the construction phase. Eight shoe stores, 14 fashion stores, six novelty stores, three national chains, two local chains and one major grocery are among the current occupants of the 73 stores. There are no plans to expand the current acreage under roof; however, individual stores in some cases have plans to increase their floor space upward.

It is perhaps most interesting to note the development in process around the mall site. Apartment buildings are under construction on land behind the shopping complex. Retail stores, banks, and service stations are built or being planned on land across the Upper Valley Pike from the mall. Work is expected to begin on SR 41 in September of 1973 to widen and build an overpass over the railroad tracks, the highway finally connecting with US 68 in a cloverleaf pattern east of the mall. Industrial and commercial development is evident in the Mad River Valley, including a large International Harvester manufacturing plant with a total work force of 7240.

The construction of a major shopping facility such as the mall can be viewed in terms of man's impact upon the environment. Levelling the area prior to construction involved the movement of large amounts of earth, cutting back a bank of land. A steep earth bank remains behind the mall, about two city blocks of the area particularly prone to mud slides. Approximately 5,000 pounds of cover vegetation have been sown to alleviate the slide condition. Springs in the area work in combination with the glacial till's propensity to absorb so much water that the clay mixture will eventually yield from sitting on a steep slope (an estimated 40-50° in some areas). The apartment construction behind the mall has resulted in earth piled close to the edge of the banks with the steepest slope.

Another effect upon the environment has derived from covering the land with buildings and with parking spaces for 5,000 automobiles. The ability of the soils to absorb runoff is affected. Concomitantly, the continued growth in the vicinity of the mall and in the Mad River Valley along the railroad lines and US 68 can be investigated for its potential effect on the quality of water and on the flood potential of the Mad River.

Trade-offs are evident in this study. Springfield has reaped industrial development benefits from the presence of the mall. International Harvester, for example, had at one time considered moving its plant from within the city limits completely out of the area. However, numerous jobs were saved by the company's building its new plant in the Mad River Valley along US 68. The development of an attractive shopping mall might be viewed as an economic shot in the arm, not only in terms of job opportunities, but also as a facility to include in an inventory to attract new enterprises to the area.

Related studies might involve investigating the effects of covering the soil with substances affecting the rate of water infiltration. Different means of preparing the construction area, and different types of cover vegetation to alleviate sliding or erosion could be compared. The environmental cost in relation to water quality or vegetation might yield interesting conclusions.

For permission contact Manager, Upper Valley Mall, Springfield, Ohio 45502, Phone: (513) 324-5703.

ADDITIONAL MIAMI RIVER WATERSHED SITES

Armstrong Museum, Auglaize County, Wapakoneta off I-75, P.O. Box 1978, Wapakoneta 45895, phone: (419) 738-8811.

As modern as the space age, this new museum includes sound tunnel, infinity tube, and memorabilia of Neil Armstrong's flight and life.

Aullwood Audubon Center, Montgomery County, on Aullwood Road near Englewood Dam, contact: Director, 1000 Aullwood Road, Dayton 45414, phone: (513) 890-9372.

Field trips led by experienced naturalists give students an opportunity to discover the great and the small in a natural world. A live museum, a restored prairie, and woodland trails are parts of the experience.

Aullwood Audubon Farm, Montgomery County, on Frederick Road adjacent to the Englewood Reserve, contact: Director, 9101 Frederick Road, Dayton 45414, phone: (513) 890-2963.

Guided tours may be scheduled for third grade students and up, coordinated with class curriculum. Soil, water, life of a honey bee, from fleece to fabric, making maple syrup, and farm management are topics which can be selected; observing farm animals, candle dipping, sheep shearing and farm gardening are additional program possibilities.

Avon Woods, Hamilton County, located at 4235 Paddock Road, contact: Cincinnati Recreation Commission, 222 East Central Parkway, Cincinnati 45202, phone: (513) 421-1652.

Only minutes away from urban and suburban addresses, this outdoor education center provides a site for studies of natural and man-made environments.

California Woods, Hamilton County, location: 5400 Kellogg Avenue, Cincinnati 45228, or contact: The Cincinnati Recreation Commission, phone: (513) 421-1652.

Tucked in among urban developments, this site provides programs for nature interpretation and ecology.

Camp Joy, Warren County, located in Washington Township, contact: Camp Joy, Inc., 2400 Reading Road, Cincinnati 45202, phone: (513) 721-8465.

This 315-acre camp site provides a study in resource management, land use and water quality through its diversified habitats and physical environment.

Carillon Park, Montgomery County, at South Patterson and East Miami Boulevards, 2001 South Patterson Blvd., Dayton 45409, (513) 293-3412.

Deeds Carillon, named for a famous associate of Charles F. Kettering, and the 64 acres of park with historical exhibits give an opportunity to experience history in a delightful way.

Cincinnati Art Museum, Hamilton County, in Eden Park at 88 Art Museum Drive, Cincinnati 45202, phone: (513) 721-5204.

Man's interpretation of his environment in paintings, sculpture, decorative arts and prints dating back 5000 years may be studied here.

Cincinnati Museum of Natural History, Hamilton County, Located at 1720 Gilbert Avenue, Cincinnati 45202, phone: (513) 621-3889.

A planetarium, outstanding mineral displays, natural history panoramas and a wilderness trail are attractive features of this oldest museum of natural history west of the Allegheny Mountains.

Clear Creek Water Study, Warren County, near Franklin and the Environmental Complex, contact: The Miami Conservancy District, 38 East Monument Avenue, Dayton 45402, phone: (513) 223-1271.

The District owns 220 acres upon which is built the waste water treatment plant which is a part of the Environmental Complex. Until an environmental studies laboratory is established, students may observe or monitor the stream to determine the effect of the sludge discharge upon the biophysical environment including the stream.

Cliffview Outdoor Education Center, Butler County, on Eaton Road adjacent to Wilson Junior High School, contact: Ranger, Outdoor Center, 1126 Western Avenue, Hamilton 45013, phone: (513) 892-8628.

A wooded hillside and valley with rugged rock exposures becomes a delightful area for teaching and learning the nature of a biophysical environment.

Clifton Mill, Greene County, on the Little Miami River at SR 72 and Water Street, Clifton 45316, phone: (513) 767-5501.

This picturesque mill at the headwaters of the Little Miami is part of a state park-camp-nature center complex which has been established as a "Country Common" to be preserved in perpetuity.

Dayton Museum of Natural History, Montgomery County, location: 2629 Ridge Avenue, Dayton 45404, phone: (513) 275-7431.

Live animals as well as other natural exhibits and an excellent volunteer training program make this an outstanding site to visit or study.

Delta Queen Cruise, Hamilton County, contact: Green Line Steamers, Inc., 330 Public Landing, Cincinnati 45202, phone: (513) 621-1445.

The Queen, the only overnight paddlewheeler in inland waters, carries on the tradition of the great passenger riverboats of the 19th century.

Eden Park, Hamilton County, along the Ohio River and the Ridge on Eden Park Drive, contact: Superintendent, Cincinnati Board of Park Commissioners, 950 Eden Park Drive, Cincinnati 45202, phone: (513) 961-6628.

This park overlooking the river and parts of the city contains a wealth of cultural buildings and natural environment.

Fantasy Farm, Butler County, on SR 4, Middletown, contact: Edgar Streifthan, Route 1, Middletown 45042, phone: (513) 539-7523.

The park and farm property give an opportunity to see domestic and wild animals and normal farm activities.

Farbach-Werner Nature Preserve, Hamilton County, located on US 27, south of 275 at Colerain and Poole Roads, contact: Manager, Hamilton County Park District, 10245 Winton Road, Cincinnati 45231, phone: (513) 521-9866.

An oasis of green in a heavily commercialized metropolitan area, this preserve offers a great opportunity for a comprehensive outdoor education program.

Flatfoot Sheep Ranch, Champaign County, on SR 296, Cable, contact: Charles C. Hess, 4499 Gray Road, Cable 43009, phone: (513) 789-3438.

This farm specializes in sheep and cattle.

Fort Jefferson Plant of American Aggregates Corporation, Darke County, located 5 miles southwest of Greenville, contact: District Manager, 3322 Stanley Avenue, Dayton 45404, phone: (513) 223-3238.

The operation consists of removal, sorting and processing of glacial gravels for various purposes. It gives an opportunity to study glacial geology, rocks and minerals, use of natural resources and reclammation.

Fort St. Clair State Memorial, Preble County, 1 mile west of Eaton on SR 122 and 355, contact: Manager, Rt. 3, Eaton 45320, phone: (513) 456-2353.

The Fort St. Clair site was one of a line of supply forts which served as a lifeline helping to win the Northwest Territory from British and Indian control. A small nature preserve adds to the experience of studying the site.

General Motors Corporation, Hamilton County, G M Assembly Division, Education and Training Department, 4726 Smith Road, Norwood 45212, phone: (513) 841-5493.

Tours to see the assembly lines of Chevrolet, Camaro, Nova, Pontiac Firebird and Buick Apollo may be arranged for students 10 years or older, any day except Thursday.

Glen Helen Nature Preserve and Outdoor Education Center, Greene County, across Yellow Springs Creek from the Antioch College Campus, contact: Director, Glen Helen, Antioch College, Yellow Springs 45387, phone: (513) 767-7331.

Steep-walled valley, springs, ferns, wildflowers and large trees make a beautiful setting for a center where well trained staff teach ecology as it relates to the total environment.

Grant Life Science Center, Montgomery County, a part of Grant Park, Washington Township Park District, 401 Normandy Ridge Road, Centerville 45459, phone: (513) 294-4000.

Dormitories, laboratories, and outdoor amphitheater with Grant Park for ecologic studies provide facilities for an outstanding nature and science program.

Hamilton Gravel Plant, Butler County, located at New Miami, contact: Vice President, American Materials Corporation, P.O. Box 291, Hamilton 45012, phone: (513) 894-8373.

Sand and gravel processing from extensive deposits in the Miami River valley makes an interesting field trip. Extraction, economic value and reclamation can be explored.

La Boiteaux Woods, Hamilton County, 5400 Lanius Lane, Cincinnati 45224, phone: (513) 542-2909 or contact: The Cincinnati Recreation Commission, phone: (513) 421-1652.

Trained professional naturalists assist in programs of hiking, bird study, ecology or environmental relationships.

Mac-O-Chee Camp, Logan County, located 9 miles NW of Bellefontaine, County Road 12, south of SR 47, contact: Buckeye Trails Girl Scout Council, 184 Salem Avenue, Dayton 45406, (513) 224-7601.

The headwaters of the Mad River, a rich agricultural belt, glacial and Indian relics give an opportunity to study ecology and man's relation to the land.

Montgomery County Incinerator — South, Montgomery County, 2550 Bertwynn Drive, Dayton 45439, phone: (513) 294-0439.

Tours may be arranged to observe this operation where refuse is burned, 95 percent complete, giving off only steam and five percent particulate material.

Mt. Airy Forest, Hamilton County, on Colerain Avenue, Cincinnati, contact: Superintendent, Cincinnati Board of Parks, 950 Eden Park Drive, Cincinnati 45202, phone: (513) 961-6628.

This forest was the first municipal reforestation project in the United States. It contains 600 acres in hardwoods, 200 in conifers, a large arboretum and an education center.

Mt. Orab Outdoor Education Center, Brown County, West of town on SR 32, contact: Outdoor Education Director, Western Brown Local School District, Mt. Orab 45154, phone: (513) 444-2505.

A former flat field now embraces a large modern school building complex and land laboratory. A pond, ampitheater made from native limestone, wildlife area and a nature trail give opportunities for ecologic and land use studies.

North Dayton Plant—American Aggregates Corporation, Montgomery County, contact: District Manager, 3322 Stanley Avenue, Dayton 45404, phone: (513) 223-3238.

This extensive extraction of glacial sand and gravel deposits is providing valuable resources for construction but creating open pits and lakes. Plans for reclamation may be explored.

Ohio Caverns, Champaign County, on SR 245, 3 miles east of West Liberty, contact: Manager, Ohio Caverns, Inc., Route 1, West Liberty 43357, phone: (513) 465-4017.

An unusually colorful and splendid display of cave features, a natural result of descending ground water in limestone layers of rock, may be seen here.

Phillipsburg Plant, Montgomery County, on SR 49, 1 mile south of Phillipsburg, contact: District Manager, American Aggregates Corporation, 3322 Stanley Avenue, Dayton 45404, phone: (513) 223-3238.

Glacial outwash sand and gravel are processed at this plant. The processing, rocks, and reclamation plans may be discussed.

Piatt Castles, Logan County, 1 mile east of West Liberty on SR 245, contact: Manager, Piatt Castles, West Liberty 43357, phone: (513) 465-2821.

These are outstanding historical Ohio homes modeled after a Norman French chateau and a Flemish structure. Tours may be arranged one week in advance.

Procter and Gamble Ivorydale Plant, Hamilton County, in St. Bernard off I-75, Mitchell Avenue Exit, contact: Tour Manager, 5201 Spring Avenue, Ivorydale 45217, phone: (513) 562-6705.

A tour for students 12 years or older may be arranged for observing some of the product processing.

Roar Island, Montgomery County, situated on Mad River, contact: Superintendent, City of Dayton Water Department, Dayton 45402, (513) 225-5392.

School groups may arrange to study this well field for municipal water supply.

Serpent Mound State Memorial, Adams County, located on SR 73, 4 miles northwest of Locust Grove, contact: Manager, Route 4, Peebles 45660, phone: (513) 587-2897.

An effigy mound in the shape of a serpent, a museum, an unusual geologic feature and choice woodland offer many experiences for students of any age.

Smucker Barn Studio, Logan County, located at the junction of SR 245 and 287, next to Mac-O-Chee Castle, contact: C. S. Smucker Family, Route 1, West Liberty 43357, phone: (513) 465-2771.

A demonstration of the spinning and weaving of natural fibers into cloth for garments and bath linens may be arranged Mondays through Saturdays.

Spring Hill Nature Center, Butler County, located on either side and back of Spring Hill School, contact: Curriculum Office, Spring Hill School, 1515 Gerard Street, Middletown 45042, (513) 423-0781.

Delightful woodland, meadow and creek trails in a relatively undisturbed area were developed by community and students. This is an excellent example of cooperative development.

Taft House Museum, Hamilton County, 316 Pike Street, Cincinnati 45215, phone: (513) 241-0343.

An example of Greek Revival architecture housing a priceless collection of portraits and landscapes and 200 Chinese porcelains. Open daily 10 a.m. to 5 p.m.

Twin Creek Water Study, Montgomery County, near Germantown Dam, contact: The Miami Conservancy District, 38 East Monument Avenue, Dayton 45402, phone: (513) 223-1271.

Property owned by the District gives access to the creek where a study of aquatic life and stream-side vegetation can be made.

Wayne Lakes, Darke County, located 6 miles southwest of Greenville on SR 121, contact: Manager, Wayne Lakes, Inc., Route 1, Greenville, 45331, phone: (513) 548-3807.

Extensive excavation for sand and gravel left 14 lakes and bare ground. Reclamation for housing and recreation formed the environment for a desirable community. Tour arrangements may be made.

Whip-Poor-Will Hills, Warren County, located on Middleboro Road between SR 350 and US 22, contact: Buckeye Trails Girl Scout Council, 184 Salem Avenue, Dayton 45406, phone: (513) 224-7601.

This camp is a wildlife sanctuary offering a diverse biophysical environment for study.

Woodland Altars Education and Retreat Center, Adams County, at the junction of Highland, Pike and Adams counties, contact: Manager, Route 4, Peebles 45660, phone: (513) 588-2100.

A well trained staff and food service are available here for outdoor education at a center rich in geology, vegetation and Indian history.

Zane Caverns, Logan County, located 6 miles east of Bellefontaine on SR 540, contact: Zane Caverns Company, Route 2, Bellefontaine 43311, phone: (513) 593-3777.

The caverns, dissolved from the limestone rocks by percolating ground water, are well worth seeing. Stalactites and stalagmites, fossils and a "bottomless" pit are intriguing features.

Muskingum Watershed Region

BACKGROUND INFORMATION

Biophysical Environment:

A trip by helicopter over this broad area would be an ideal way to grasp the concept of green hills and broad valleys intermingled with fields, factories and strip mines. Looking at the geologic map one readily sees that most of the watershed is underlain with Pennsylvanian and Permian sandstones and shales. Not evident is the fact that these strata are interbedded with a number of coal seams that make Ohio a leading coal producing state.

The area is largely beyond the line of glaciation. The impact of this phenomenon, however, is reflected in the many stream modifications and outwash sand and gravel along the valleys of the rivers. In many places picturesque sites developed by stream reversal, a situation which was created when the glaciers blocked normal stream flow moving in a north or western direction. This forced the great volume of meltwater from the glaciers to flow south and east, carving deep ravines and gorges. Striking examples of these may be visited at Clear Fork Gorge in Mohican Forest, Beaver Kettle Farm and Beavercreek State Park in Columbiana County, and Troyer's Hollow in Holmes County. (See *A Guide to Ohio Outdoor Education Areas.*)

The rock formations in this scenic region provide more than beauty. In addition to the coal extraction mentioned before, it has some of the richest coal reserves on the continent. The region has one of the world's largest concentrations of clay industries. Salt processing, limestone mines and sandstone quarries have furnished the state with more mineral resources than has any other part of the state. Oil and gas discovered early in the region contributed greatly to this mineral wealth and continue to be a valuable resource.

Beyond the line of glaciation, the hills and valleys reflect the millions of years of persistent erosion forming rounded hills and broad valleys with meandering streams. Frequent exceptions may be found where a resistant layer of sandstone forms overhangs and waterfalls, characteristics of youthful erosion, as opposed to the mature marks of erosion in the rounded hills. Parts of the Mohican Forest and the Hocking Hills parks show features typical of the Mississippian Blackhand formation. Canters Cave, Liberty Wildlife Area and Richland Furnace Forest are carved in the hard Sharon Conglomerate of Pennsylvanian Age.

The several maps—geologic, glacial, soil and vegetation—vividly reveal a correlation of each with the others. The soil change from low-lime till covering the hills in northern Columbiana and Stark Counties, all of Wayne, Richland and the upper part of Holmes County, and a small portion of eastern Knox and Licking County changes fairly abruptly to the thin, residual sandstone and shale soils beyond the penetration of the glaciers. The line on the vegetation map "duplicates very closely the boundary of the Wisconsin glacial deposits" (Jane L. Forsyth, Ohio Journal of Science, May, 1970, *A Geologist Looks at the Natural Vegetation Map of Ohio*). Further, "to the west of that line are till plain beech-maple forests (called 'Beech Forests' on Gordon's Map); . . . to the east of that line are unglaciated mixed oak and mixed mesophytic forests."

It is the Muskingum River, itself, which establishes a unity for the region. This watershed region covers more than one-fifth of the state's total 41,000 square miles if the several small rivers flowing directly into the Ohio River from this region are included.

The Muskingum with its four large tributaries, the Tuscarawas, the Walhonding, the Licking and Wills Creek, is the largest river lying wholly within the state. Headwaters rise as far to the north as Medina County, northeast in Stark County, and northwest in Richland County. The Tuscarawas and Walhonding have their confluence at Coshocton, while Wills Creek and the Licking River join the mainstream at Conesville and Zanesville respectively. As it makes its leisurely way down hill to Marietta, where it becomes a part of the Ohio-Mississippi waterway, it accumulates great volumes of water and breadth of valley. It runs gently from an elevation of 738 feet at Coshocton to 585 feet above sea level at its mouth.

But the Moos-kin-gung, named by the Delaware Indians and meaning "Elk Eye River" because of the herds of elk that roamed the valley, has had a long history of serious flooding. One of the greatest chapters in its history tells the story of the people who succeeded in harnessing volumes of water for flood control, water supply and recreation.

Socio-cultural Development:

Paleo Indians were the first human inhabitants of the state, having followed the movement of the animals and the wasting glaciers. This is evidenced by the finding of their tools made from Licking, Muskingum, and Coshocton County flint. As climate became warmer and drier, other cultures moved in, possibly from the Mississippi Valley, and spread widely throughout the state, particularly in the large river valleys. They were called Adena, Hopewell and Middle Mississippian, and their history extended over the period 1000 B.C. to the dawn of the historic era in the mid-seventeenth century. Nearly 400 mounds and other prehistoric sites have been found in the counties through which the Muskingum flows. On the site of Marietta, the Hopewells erected two earthworks in squares containing 50 and 27 acres. An Adena council mound lies inside the present "Mound Cemetery." Within the larger enclosure are three platform mounds built by the Middle Mississippian people as bases for structures in which ceremonies were held. Newark in Licking County contains a portion of extensive earthworks situated on the west side of the city. The large enclosures are attributed to the Newark group of the Hopewell Indian culture. Ohio's prehistory reveals fascinating evidence of hard working people who showed various ways of living, each with a special type of economy, art, social structure and religion. They added much of value to both our Ohio and our national heritage.

As soon as direct contacts were made between the early Indians of Ohio and European settlers and records were maintained, the age of the prehistoric Indians came to a close.

Although a few of the fierce Shawnees inhabited the upper Muskingum Valley, most of the Indians in historic times were Delawares. At the time Columbus happened upon America, this tribe lived along the Delaware River and Bay on the east coast. About 1750, persecution by the powerful Iroquois and pressures from the European settlers pushed them many miles west to the Muskingum and Tuscarawas valleys. But their possession of this land, too, was soon threatened. The French in Canada, in their effort to claim the Ohio Valley, sent a flotilla of 250 men down the Ohio River, landing at the mouth of the Muskingum across from the site later to be settled as Marietta. The English also claimed the region reaching as far as Coshocton in the mid 1700's. The French and Indian War (1755-63) was a fight for possession, in which the French were defeated and the Indians remained hostile. An exciting summary of a real effort to pacify the Indians centers around the English Colonel Henry Bouquet, who built a camp at Coshocton and managed to retrieve white captives and maintain in the depths of the wilderness a peace for thirty years. Moravian missions were also established in the Tuscarawas valley very early, contributing concepts of peaceful cohabitation for a few years.

In 1785 Congress signed treaties which gave the Indians a reservation in northern Ohio and ceded the remaining land to the new American nation. After passage of the Ordinances of 1785 and 1787, which provided for settlement and government of the Northwest Territory, the Ohio Company bought 1.5 million acres in southeastern Ohio for settlement. In 1788 Marietta became the first organized permanent American settlement in the Territory. As a precaution against Indian attack, the pioneers established a fortified square which they called Campus Martius. A visit today to this site in Marietta is a rewarding experience and recalls the excitement and fortitude exemplifying the pioneering spirit of these and other early Ohio settlers.

Settlement developed steadily along the Ohio and proceded northward along the large rivers of the state which drain into it. Canoes, small boats and later (1824) steamboat transportation made travel easier and faster. In 1831 Coshocton was connected to eastern markets by the Ohio Canal with a sidecut two and a half miles long, from Adams Mills to Dresden, linking the canal to the Muskingum River. Zanesville was connected by two land routes to distant markets: the National Road extending from Cumberland, Maryland, to Wheeling, West Virginia, and westward through central Ohio; and a new road built down the east bank of the Muskingum to Marietta.

In 1836 the first locks and dams for Muskingum River improvement were authorized by the Ohio Legislature in order to facilitate river transportation. Except in flood times the steamboats had had difficulty making their way up the river. The age of steamboats stimulated agriculture and industry and brought merchandise from eastern markets. The canal boats and the river steamers carried passengers and made life for the early Ohioans much more pleasant.

Although Ohio was not an important battleground in the Civil War, which followed these developments, residents from New England provided stations for the Underground Railroad, and Confederate Captain John Morgan's Raiders terrified sections of the Muskingum country.

After the Civil War steamboats continued to find their way up and down the river, but about this time railroads entered the picture and began draining away the freight trade at both ends of the valley.

Population increased as transportation improved. As roads, canals, and railroads crisscrossed the state and connected the Muskingum River with markets, industries developed rapidly.

Zanesville, settled in 1797, became "The Clay City" in this period. In 1810 the first commercial pottery was opened and farmers began making the famous "Blue Bird" stoneware. Floor, wall and vitreous tile followed. The plants making them became the largest of their kind in the world. Zanesville was also the largest art pottery center in the world when the Weller, Owens and Roseville potteries were operating at capacity. Although discontinued, their pottery is still eagerly sought by discriminating collectors. Glass, brick and pipe were also made in Zanesville, the glass plant being the first major glass producer in Ohio. The manufacture of farm implements, ships and steel followed. Industries needing the sheet steel processed by Armco for electrical components moved into the Zanesville area; Timken Roller Bearing and Detroit Harvester were to come later. Population grew to over 40,000 people by 1957, but has decreased since that time.

East Liverpool, a city built on the hills rising from the Ohio River north and east of Zanesville, was to become the pottery center of Ohio after 1839, when

James Bennett, an English potter, judged the clays in the surrounding hills to make an excellent quality yellowware; white and semivitreous china and porcelain electrical fixtures and supplies developed later. Local clays are still used for the original ware but now most raw material comes from distant states, Canada and Italy. Labor saving machinery displaced the potter's wheel at an early date.

Cambridge, a small city of 13,000 in Guernsey County on Wills Creek, changed gradually from a small agricultural trading center into a specialized area for the fabrication of plastic parts for radio, automobiles, television, business machines and home appliances. The oldest establishments turn out glass and glass products. All the industries are obviously dependent on economical electric power. The proximity of thirty-five operating coal mines in Muskingum County alone and the operation of one of the nation's largest steam-power electric plants at Philo are ready sources. Near Cambridge is Salt Fork State Park with more than twenty thousand acres of rolling hills, some of which were formerly farmed or stripped for coal.

Steubenville is described by some historians as having the best townsite on the Ohio River. Its population steadily grew until 1950 when, like other hill towns, it decreased. Steubenville is principally known for the manufacture of iron and steel, although the Steubenville Pottery, originally set up largely with skilled labor from the Staffordshire district in England, represents the clay industry with semi-porcelain dinnerware.

Martins Ferry, another upper Ohio Valley city, was the home of a Jones and Laughlin Steel plant from 1880 to 1937. Periodic flood damage and the exhaustion of several coal mines in the vicinity accounted in large part for its closing. The loss of its large payroll was a shock from which the community finds difficulty in recovering.

Marietta, named for Queen Marie Antoinette of France, appeared to be a prepossessing townsite to the pioneers who settled at the mouth of the Muskingum. To the usual flour and grist mill, tanyards, and sawmills, Marietta added a woolen mill and a flourishing sandstone industry. Marietta College was founded in 1835. But industrialization was slow. After World War I the chemical industries became important, leaning on local brine, fuel, and water for processing as well as cooling and eliminating wastes. The growing markets between the river and Lake Erie contributed also to their development. Electric furnaces for ferro-alloy for steel making were built in 1951. These are dependent upon the continuous supply of low cost bituminous coal strip mined at nearby Dexter. The Ohio River serves as their source of water for cooling.

Although waterways and mineral resources have been of tremendous importance to the development of the Muskingum country, the desire for farm land was a part of the "Ohio fever," which spread through New England and brought migrants to the region. The thin soils of eastern Ohio at the outset produced about as well as the deeper soils in the Miami Valley. The Appalachian Plateau hill land was reasonably familiar and even the climate was not too different. South of the Western Reserve in the northern part of the Muskingum region, Germans and Scotch-Irish from Pennsylvania moved into the territory. Militant Scotch Presbyterians, Pennsylvania-German, Amish and Dunkards, and Swiss Mennonites in Wayne and Holmes counties, many of whom had lived in Alsace, have left a strong imprint upon the state to this day. Ohio's "Little Switzerland" is a lovely mixture of "Dutch" speaking peoples who share the community interests of Swiss cheese makers.

Self-sufficing and part-time farming early became a pattern; dairying, poultry, cattle and truck produce mixed in many cases with part-time coal mining. Sheep in eastern and southeastern Ohio were once an important commodity which has now declined. Despite this decline, it remains a fine wool producing region. Other specialties persist throughout the region.

Several other large cities are included in this watershed region although in many respects they might well be grouped with the northeastern battery of urban centers.

Canton and Massillon in Stark County have contributed significantly to the state's reputation as a steel maker. Together they are known as the Central Alloy District. The Ohio and Erie Canal passed through Massillon, making it the greater of the two for many years. The manufacture of farm machinery for the agricultural trade gave Canton an edge and it soon achieved a world reputation for these products. Modern alloy steel manufacture came in the late 1800's, when the predecessors of the presently-dominant Republic Steel Corporation came in. A second industrial giant, Timken Roller Bearing, appeared on the scene in 1904 and has now become the world's largest producer of electric furnace steel, its own officials assert. This came about because the need of special steel for bearings led the company to open its own furnaces.

Wooster is the home of the oldest of Ohio's research institution, called for 83 years "The Agricultural Experiment Station" and later known more accurately as the Ohio Agricultural Research and Development Center. The center, with its 2000 acres south of the small but significant city, has a research program designed to benefit Ohio's 114,000 farm families. There are four substations, two in the

Muskingum Region, one for forestry and contour farming, and another for Washington County's vegetable crops. Wooster College reflects the strength of the Presbyterians who settled in the area.

Mansfield, a city of 43,366, has a diversified manufacturing economy attuned to remote rather than local markets. It had no canal, no minerals; its site was not particularly strategic. It has capitalized, like many other Ohio cities, upon its proximity to resources and markets. In a Mansfield park stands a blockhouse built in 1813, the only remaining blockhouse in Ohio. It is maintained as a memorial to Jonathan Chapman, known through Ohio, Illinois, Indiana and Michigan as Johnny Appleseed. Famous for leaving and planting apple seeds throughout Richland and Ashland counties, he continues as a popular legend in Muskingum country history.

Newark, situated on the Licking River, has long been the center of a prosperous agricultural area on the western margin of the Appalachian Plateau. Newark grew slowly after its founding in 1802, despite the fact that the Ohio and Erie Canal reached it in 1832. In 1893, cheap natural gas and an available silica supply attracted the glass industry to Newark, which was followed by Kaiser Industries, Western Products for food packaging, a munitions plant, electric ranges, and axles and brakes, the central location for market being the prime attraction. The influence of Welsh settlement, particularly in the "Welsh Hills" of Licking County, is still noticeable.

Mt. Vernon, another trading center in a rolling, fairly productive farmland, has maintained a competitive position in manufacturing also. Its location and growth were influenced considerably by the availability of natural gas.

Environmental Impact:
Land use and resource management are exemplified by the Muskingum Watershed Conservancy program.

The Muskingum River with its great tributaries has had a unifying effect upon the area since its beginnings. Settlements and cities were built along its course, frequently at the confluence of two streams, more often than not to some degree upon normal flood plains. From pioneer times the river had frequently overflowed its banks. Destructive floods came in 1884 and again in 1898. People along the rivers thought they had seen the greatest havoc possible. But in March, 1913, a greater flood proved them wrong. Heavy rains over the Ohio Valley provided torrents of water which rushed down the hills. At Zanesville water rose 26.8 feet above flood level, at Marietta 22 feet. The raging waters devastated homes, bridges, roads and railroads. Five hundred lives were lost and property damage reached three hundred million dollars throughout Ohio (Muskingum County, Muskingum Water Conservancy District).

As a result of this catastrophe, which extended into the Miami Valley and other parts of Ohio, in 1914 the General Assembly passed the Conservancy Act which provided for the establishment of a governmental unit to deal with floods and conservation problems. A Conservancy District may be formed if it has enough public interest and support. It can levy assessments, condemn land, enter into contracts and otherwise operate to control floods, regulate rivers, purify streams, provide reforestation and recreation.

In 1927 the citizens of Zanesville raised money to find a way to stop floods. By 1930 citizens throughout the valley joined in an effort to control their waters. They established a Conservancy District and with the help of state funds they drew up a plan to provide for a series of 14 dams, most of them back along the feeder streams. Ten dams were to impound permanent pools, thus providing lakes for recreation in a region devoid of natural lakes. Cooperation of local, state and federal bodies brought the program to fruition in 1938. Reforestation was an immediate concern which proved to be one of the major contributions to a successful program. In addition, contour farming and other conservation practices have meant that siltation in the dams has been a minor problem. In retrospect the program has benefited Ohio greatly. Louis Bromfield made the following statement: "The Muskingum Watershed Conservancy District is probably the greatest example up to now in all civilization of man's understanding of how to develop his natural environment to his greatest good."

Energy, Land Use, Resource Management, Air and Water Quality:
In the Muskingum Watershed Region these environmental concerns are variously intermingled. The steady increase of settlement and subsequent development from agriculture alone to a combination of agriculture, industry and business came about because the mineral resources were readily at hand, the technology available and labor accessible. Coal, gas and oil provided the source of energy; steam electric power plants sprang up to process the coal to feed to the industries. Gradually strip mining came into prominence, and now approximately 73% of Ohio's coal is mined by stripping operation in response to the low economic value of the surface land, the horizontal coal seams, the shallow overburden (rock and soil above the coal seams) and the high labor cost for deep mining.

Coal mines and mining communities in most of the plateau counties, the stripping operation, which leaves barren spoil banks and unnatural gouges on the landscape — all are far from lovely to see. The

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heavy siltation of streams and acid drainage caused by oxidizing iron minerals (pyrite) into the waterways have resulted in much protest on the part of conservation-minded Ohioans. Power plants have been belching forth great quantities of sulphur oxides and particulate matter which adversely affect the air quality. The land, once stripped, resists vegetative growth. Industries and cities utilizing the power produce more air and water pollution.

Ohio's coal appears to be a mixed blessing. The first strip mine law in 1947 was a small step toward reclamation. Much land had been laid bare before that time and lay unreclaimed. These lands and the acid mine drainage from abandoned mines slow efforts toward reclamation. Encroachment on the rights of people adjacent to mines and various other ills led to the passage in 1972 of one of the country's most stringent reclamation laws. The law has two purposes: to protect the environment by eliminating the abuses connected with strip mining and to permit the mining of coal by careful operators who use good mining practices. The goals of the Department of Natural Resources, which has the responsibility for enforcement, are fourfold: to eliminate water pollution, to require mined land to be returned to its original or to a better condition, to regulate operations in a fair and evenhanded manner, and to protect the personal and property rights of persons living near strip mines. Costs of reclamation are estimated to be higher, which in turn promises to raise the cost to the power companies and hence to the consumer.

Coal and its tangential problems are not responsible for all the ills of the valley. The United States Hydrological Research Station above Coshocton has worked since 1936 to study runoff, rainfall, soil and water pollution, sedimentation, strip and contour farming, effects of plantings and other conservation measures. Its efforts have benefited the area greatly. But problems there still are. It will take the combined efforts of citizens, industry and governmental agencies to modify the ills to a tolerable level and maintain a quality environment in Ohio's most scenic area.

Acid mine drainage from an abandoned mine

ALPINE ALPA CHEESE FACTORY

Location: on US 62, south of Wilmot.

The description of cheese making fits into the historical setting of a part of Ohio settled by Amish and Swiss farmers. The Amish, a German religious sect which came to Ohio in the early 1820's, have as many as 16,000 members living in the state, a high proportion in rolling hills and broad valleys of Tuscarawas and Holmes counties. Although not so numerous, Swiss migrants have intermingled with the Amish and maintain excellent farms and enduring communities. A bus field trip beginning at Sugar Creek might include a stop at a cheese factory there, a blacksmith shop and a Swiss Festival held in the fall of each year. South on SR 93 to 557 to the little village of Charm is a scenic trip to another Swiss operated cheese factory and a village store where practically all the needs of the Amish may be purchased from its Swiss owner. From Charm back up to US 62 and Millersburg brings the tour directly into a trading center for the Amish where a hitching rail alongside the courthouse is maintained for the horse-powered Amish buggies. An Amish Festival is held here in October each year. A backtrack again on US 62 to Berlin gives an opportunity to stop at a wool mill which sells braided rugs made by Amish women. Route 39 goes from Berlin to Walnut Creek where a Holmes County Branch Library contains everything from writings by local Amish people to encyclopedias for Amish school children. A restaurant on the square cooks and serves Amish food. SR 515 returns to US 62 which leads to the Alpine Alpa Cheese Factory just south of Wilmot.

The factory is owned and operated by a charming Swiss woman born in the mountains of her homeland where she yodeled and sang as all Swiss do. Her factory, Swiss chalet store and coffee shop are the epitome of cleanliness. She features fifteen different kinds of cheese; the specialty is mild, medium and aged Swiss cheese. Others include Muenster, cream brick, alpa-horn, baby Swiss and natural smoked. Outside at the entrance to the coffee shop is the world's largest cuckoo clock, an intriguing novelty to the passerby.

The making of cheese and its use by herdsmen thousands of years ago is only vaguely recorded. The Old Testament contains references to it, and the Greeks and Romans are supposed to have used cheese as a staple food before the beginning of the Christian Era. Swiss cheese and black bread are traditional mountain fare for herdsmen in Switzerland. It is small wonder that the food was introduced into the United States by the various international groups that found their way to the new country.

Alpine Alpa has been in business since its owner came to eastern Ohio 26 years ago. The factory is now a showplace of cheesemaking with bus loads of school children and carloads of tourists visiting it every day in the week except Sunday.

Fresh milk is brought to the supply entrance daily from the Amish farmers and by truck from many other farms in the surrounding area.

The Swiss cheesemaking begins in old fashioned, shining copper kettles, several of which are lined in pairs down the long room. The Swiss cheesemaker adds rennet, a natural enzyme, which serves as a thickening agent for the 2200 pounds of milk in each kettle. After a half hour thickening period, the curd is made with a Swiss harp or many-pronged fork which cuts the mixture into curds about the size of a kernel of wheat.

Only four hours from the time the milk is received, the curd is ready for dipping. A hemp cloth is passed through the kettle to collect the curd, separating it from the whey, the thin liquid remaining. The curd from each kettle is then pressed into a large rectangular mold. The curd cheese is dressed with clean cloths several times during the day to aid in removing additional whey. Seventy-five percent of the milk is whey, a by-product which is often dried into a powder and sold to food processors.

The next morning the Swiss cheese is put into a bath of salt brine which cools it and makes it firm. Other cheeses have salt added to the curds before they are placed in molds. After two days of floating in the salt brine, the Swiss cheese is removed and placed into a warm (72 degrees) cellar to undergo a fermentation process. This is where the holes, or the "eyes" as the cheesemaker calls them, are formed.

The cheese is checked for eye formation and texture after five or six weeks in the warm curing cellar. If satisfactory it is moved to cooler storage for further aging. Two months are necessary for mild cheese; six to eight months for medium, and one to two years or more for sharp or aged Swiss cheese.

Huge stainless steel vats are used for manufacturing the other kinds of cheese. No preservatives are added. The cheeses are molded in small round containers and require only a period of five weeks to age. Then they are ready to be sold in the chalet store or sent to all parts of the nation.

The production of cheese has increased in recent years due, in part, to the fact that less milk is used to make butter. Thus cultural patterns tend to change industrial output. Although it is difficult to present comprehensive food value figures for such a variable food as cheese, hard, whole milk cheeses are about 25 percent protein and 31 percent fat and give approximately 1,757 calories per pound.

The Alpine Alpa factory is one of the few which conduct educational tours and provide visual aids for understanding the process of cheesemaking. This makes it possible to receive visitors at almost any stage in production.

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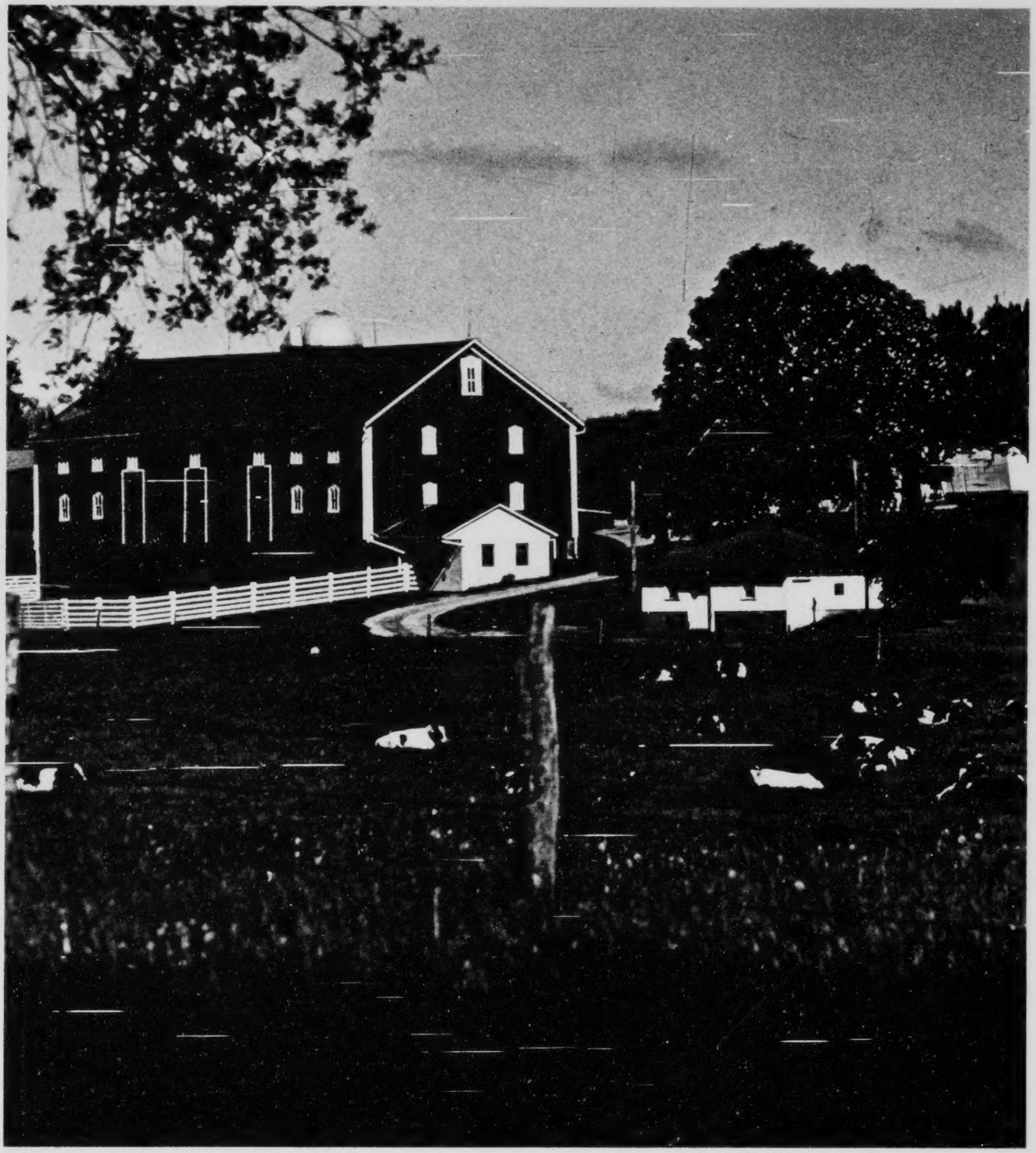
Like the crafting of blown glass, cheesemaking requires skill and experience. Unfortunately master cheesemakers are passing from the American scene and unless capable and loyal people can be trained to assume the responsibilities, much of the skill will be lost. Scientific testing aids in obtaining a uniform product, but the need for the master craftsman remains.

Guided tours may be arranged by appointment for Monday through Friday between 11 a.m. and 2 p.m. contact: Alice J. Grossniklaus, Wilmot 44689, phone: (216) 359-5454.



From Stark County farms comes milk for cheese

BLACK HAND GORGE

Location: This area of 740 acres immediately northwest of Toboso is one of the richest possibilities for study of highly diversified changes, both geologic and man-made, with chief emphasis on land use.

Historically this area has excellent examples of man's impact on the environment since prehistoric Indian times. At one time what appeared to be the figure of an oversized human hand was visible on a high rock face. The legends concerning the "Black Hand" range from the fanciful — disgruntled lover, lover's leap, patricide type — to the more prosaic possibility of lichen-growth or natural mineral stain. Generally, it is accepted that it was an Indian-made indication of the direction of Flint Ridge, five miles to the southwest. Old literature tells of a mound and the frequency of chips in the area, but little evidence remains of actual Indian use.

The earliest factual remains of man's impact date from 1828, when the hand reputedly was blasted away in the construction of a part of the Ohio Erie Canal. Remnants of a lock, an aqueduct, and the towpath remain, though the canal functioned only 15 years, until 1848.

The next historically interesting event concerns the Central Ohio Railroad. Built in the mid-nineteenth century and in use only for six years, it left a slash through the rock 64 feet deep and 100 feet long — a tribute to hand labor which functioned in spite of epidemics.

From the early 1900's are found ruins of quarry works utilizing 98.9% quartz sand in the manufacture of glass (which, judging from present discards, may have had a homing instinct).

At about the same period a tunnel for an electric railroad, an interurban line, was cut through Red Rock, opposite the Black Hand Rock. Variously claimed as the first such in the United States and as the only one in the world, it remains passable for its entire 250 feet.

An old bed of a railroad is still visible as is its relocation (at the time of the construction of Dillon Dam); the relocated track is still in use.

Geologically this is the site of the widely famed Black Hand formation, a sandstone of Mississippian age. It is well exposed in the narrow, three-mile gorge (the Narrows) cut by the Licking River through cross-bedded, conglomerate rock. One outcrop, known as the Black Hand Rock, is circular except where it forms a 50-foot cliff along the river. The gorge was formed partially by normal erosion and partly by stream reversal due to glaciation. Other points to be observed are the horseshoe-shaped abandoned channel remains of the old river bed; well developed fluting and honeycomb pitting and the black erosional sulfur-produced surface on the sandstone cliff faces.

Botanically this has long been a popular attraction for students. Its original vegetation included chestnut as evidenced by dead snags and an occasional root sprout. Cutting and sheep grazing have left their impact, but many outstanding hemlocks, a few prairie plants along the railroad, as well as a wide selection of herbaceous plants typical of acidic soils make this an outstanding study area. Extensive woody plantings have helped to restore and preserve the beauty of waterfalls, with their attendant liverworts, mosses and ferns, as well as the highly diversified selection of wildflowers.

Abundant signs of animal life are present for those who would read the landscape. These include deer and pileated woodpecker. The bluebird population probably was increased by the many nesting boxes erected by the Licking County Audubon Society.

The Toboso Black Hand Gorge Tour Guide Project by the Toboso Elementary School is a blend of natural and human history presented in a unique manner. Curriculum guides, taped talks, guided tours, display materials, and dramatized legends have been developed and are presented by the children themselves for visiting school classes.

Most of the Black Hand Gorge is planned to be a part of the State of Ohio Natural Area Preservation program as authorized by Public Law 113. Ohio's program of preserving original natural features which remain relatively unspoiled has been authorized only since 1970. Many thousands of acres throughout the state have been designated for management and protection for educational and scientific use and visitation. The efforts of organizations such as Nature Conservancy, the local Audubon Society and owners like Miss Marie Hickey, who desired to preserve in perpetuity the beauty of her land, have made possible this inclusion. Construction of Dillon Dam has helped to focus attention here.

A trip through the gorge should include a visit to Cornell Steps carved into a nearby cliff and once the scene of a park and picnic area, a popular stop on the electric railway.

The gorge area may be visited during daylight hours, with special permission only. Picnicking, camping, and mass recreational activities are not permitted. There are no facilities available. To visit the nature preserve contact: Ohio Department of Natural Resources, Belcher Drive, Fountain Square, Columbus 43224, phone: (614) 469-3770.

For information concerning the program offered by the Toboso Black Hand Gorge Tour Guide Project contact: William E. Weaver, Toboso Elementary School, Route 4, Newark 43055, phone: (614) 763-2342.

CANAL FULTON BOAT TRIP

Location: Off Ohio Route 93, five miles north of Massillon.

The canal boat, the St. Helena, an authentic replica of the old coal and grain freighter which used to float the Erie Canal, can take the visitor back in time, generating a new awareness and sensitivity for our past. The freighter itself represents a tremendous body of knowledge and skills that went into bending the planks, sealing them together, hand carving the woodwork, and casting the ironwork trim. As they travel down the old Ohio Erie Canal, youngsters can gain insights into the canal itself, why it was built, and how it was constructed almost 150 years ago.

George Washington was actually the first person who saw the need for a canal system in the Ohio Territory. He envisioned it carrying goods and people from Lake Erie to the Ohio River. In 1825 the work began with thousands of men and animals. Three thousand men and 2000 animals worked on the stretch between Cleveland and Akron alone. Digging this 308-mile-long channel was greatly hampered by the mysterious "canal fever" that killed the Chinese, Black, and Irish workers by the droves. It has been said that there is one dead Irishman for every yard of that canal. Every foot of the canal channel was dug with the simplest tools, the pick and shovel. For seven years men gouged the four-foot-deep canal from the earth. By 1832, it was complete and carrying the coal, lumber, and grains which spurred the development of so many towns along the canal, including Portsmouth and Akron.

It is difficult to envision the wild days of the canal worker when entering the present day peaceful village of Canal Fulton. The canal worker was often found in a small section of town known as "Brimstone Corners" where he would quench his thirst and reduce his frustrations with an occasional lively brawl. A lush green city park lines one side of the present day canal, while a restaurant, the foot of extensive backyards, and vacant woodlots line the other.

St. Helena II was constructed along the banks of the canal in the village of Canal Fulton. Thousands of man hours were invested in the project, which took over three and a half years to complete. During 1967 the first oaks were cut for the wide planks of the hull. They were boiled, then bent to form the smooth curves of the hull. In the winter of 1968-69 the men finished planking the hull under a plastic bubble housing the boat. Then the boat was turned upright from its resting place on two telephone poles, and the deck and cabins became the next chore for 1969-70. By June of 1970, St. Helena II, the country's first authentic replica of a canal boat, was ready for christening.

Support for the freighter project came from a variety of businesses and individuals who contributed well over 15,000 man hours of volunteer time and nearly $25,000. The Stark County Historical Society has been one of the most constant supportive groups, and it now operates the boat and annually contributes to maintaining an Erie Canal Museum in the village.

The 60-foot long St. Helena II is made of solid white oak sealed together with okum and cotton, then painted bright white with algae resistant paint. In the original canal boats, the aft cabin was used as home for the captain and his family. In the middle was the stable cabin for the mules, while the forward cabin held the cargo — several hundred pounds each of coal, lumber, and grains. Instead, the St. Helena II carries 60 passengers comfortably and even has a convertible top awning for weather protection.

Two mules attached to a 125-foot rope pull the boat down the canal at the maximum speed of four mph to prevent waves made by the boat from eroding the shoreline. Although the water is thick with green algae, showing the canal's age, the shoreline has remained intact because of this four mph rule.

The hour-and-a-half round trip up the serene canal is surprisingly smooth, unlike any other boat ride. What the sad-eyed, floppy-eared mules lack in grace and beauty, they more than make up for with their great strength and endurance.

When the boat arrives at the turning basin, it slowly makes an about-face passing Lock 4 Park Pier. This is one of the most beautiful parks in the county, offering picnicking and the serene peace of the canal's glassy surface overshadowed by large weeping willows. Visitors can see the 10-foot-high lock as it was originally built, then easily imagine how it works and why 153 others were needed along the canal to act as steps for reducing the slope of the canal downstream.

A canal trip is not complete without a visit to the Erie Canal Museum, which has a fascinating collection of photographs of the whole Erie Canal system as well as displays of tools used to make canal boats.

Seeing how history, environment, economics, geography, and politics interacted to solve a transportation problem provides an excellent model for understanding the variety of elements needed to solve current environmental problems.

With a few weeks' advance notice, teachers can bring two classes on a ride at a time. The trip is available from May through October. Fees are $1.50 for adults and 75¢ for children. Contact: The Stark County Historical Society, P.O. Box 483, Canton 44701, phone: (216) 455-7043, (216) 854-3808 (ticket office).

COLUMBIA CEMENT COMPANY

Location: Off U.S. 22 at East Fultonham, Muskingum County.

Early Ohio history tells of rough and muddy roads which made communication, travel and commerce by the settlers almost impossible. This study of resource management deals with native Ohio materials processed to form a little-thought-of product, cement, which, along with the automobile and its comfortable tires, makes Ohioans ubiquitous. In addition to providing smooth highways, it is the base of construction materials for a wide variety of structures we now consider essential for daily living.

The use of the term cement or commonly, Portland cement, refers to a fusion of raw materials by burning in a kiln which is then ground to a powder and added to aggregate (sand and/or gravel) to form a ready-mix concrete.

Very little definite information about the preparation and uses of cement can be found before the 18th century. However, the use of burned gypsum and lime goes back to the time of the Egyptians. A "Roman" cement, named no doubt after the stubborn structures built in Roman times, was manufactured in 1796 by an Englishman named Parker. Since that time the industry and the uses have expanded rapidly, in Europe, and thence to the United States. Bellefontaine in Logan County still has a renowned paved city block, the first in the country, laid down in 1891. Cement became Portland cement in 1824 when it was claimed that cement "equals the best merchantable Portland stones in solidity and durability."

Although the modern product has improved in tensile strength many times beyond that combination of materials referred to, the term Portland cement now is the common term for the fused limestone, shale and sand product, finely ground, which is used for concrete.

In 1919 the Columbia Chemical Corporation of Barberton, now the Barberton plant of PPG Industries, Inc., acquired a small limestone quarry near Zanesville. Limestone was used in the manufacture of soda ash (calcium carbonate and sodium chloride), and soda ash in turn was used in the manufacture of plate glass. Barberton could use only four to eight-inch sizes, but the crushing operation left five to six hundred tons of limestone and shale of smaller sizes per day; consequently, that which couldn't be used for roads, railroad ballast, and agricultural lime was dumped into a part of the old quarry. It accumulated so rapidly that it began to present a problem. To solve it, PPG Industries decided to build a two-kiln cement plant to utilize the crushed stone as well as the shale immediately above the rock layer. In 1924, the first year of production, the plant capacity averaged 2500 barrels per day. The kiln capacity was increased and today it is 10,500 barrels per day.

The plant is located geologically on the shales which top the Maxville limestone formation deposited late in the Mississippian period. The calcareous material precipitated as a limy ooze on an ocean floor with fossils occurring at certain horizons. The later rock, including the Mississippian, formed in the seas that covered Ohio through its early geologic days, contains few limestones. The seas were seldom deep enough or remained long enough for abundant marine organisms to live and die and accumulate as beds of limestone. That is why the Maxville formation is an unusual feature for this area. "The Maxville is found only in patches as it was deposited on an irregular surface and much of it was eroded before the later sediments were laid down." (Aurele La Roeque and Mildred Fisher-Marple, *Ohio Fossils*, Division of Geological Survey, 1959.)

Subsequent deposition of shales, followed by uplift, together with 200 million years of erosion, make the hilly topography, and the limestone is now exposed many feet below the tops of the hills but extending for considerable distance within.

The first part of a trip through the plant consists of a wagon ride behind a tractor straight into the hillside and the working face of the mine. Thirty-by thirty-foot pillars are left, as the limestone is removed. These pillars support the roof and the overburden above. Ventilation is provided in accordance with standards established by the Ohio Division of Mines by means of pulling air through entries and breakthroughs.

The rumbling wagon passes the machine shop where the equipment is repaired and kept in condition, past storage rooms and workshops.

At the face of the mining operation pneumatic drills are used to drill 37 holes two inches in diameter and 11 feet deep horizontally into the wall in a space 18 feet high and 30 feet wide. The holes are loaded with dynamite and exploded by using a series of delayed action blast caps, until the entire face of stone is shot down. This is done at night at the end of the second shift after everyone has left the mine. The pillars are later reduced making recovery of approximately 90% of the stone possible.

The stone is loaded and hauled to the underground crusher with front end loaders and 23-ton trucks. At the crusher, which is seen on the return trip, the stone is dumped into a jaw crusher, then a hammer mill to reduce the stone to less than one-half inch. Conveyors carry the screened stone to an underground bin.

About one day a week the mine crews load and haul the shale which is exposed above the mine entrance and run it through a crushing system to fill a shale bin underground.

The correct proportions of these materials — 86%

limestone, 11% shale and 3% sand, the latter brought in from a sandstone quarry — are pulled from the bins by separate feeders and sent to a huge raw mill bin at the plant above ground. The raw mill operator controls this system by electronic devices and industrial television.

It is possible to see the mixture of raw materials fed with water into huge containers holding 50 tons of steel balls varying in size from one and one-fourth inch to three inches. As these mills rotate, the steel balls may be heard tumbling in the material. They grind as they rumble, until the material is fine enough for chemical action to take place in the kiln.

Part of the slurry, the finely ground rock material and water, has a low lime content and part has a high lime content. Both kinds are drained into correction tanks where each is sampled and analyzed by the control laboratory and then blended in the required proportions to yield a chemically correct slurry in the kiln feed basins. By scurrying up and down a few flights of steps around and above the gigantic tanks it is possible to see the process in its entirety.

The corrected fine muddy mixture is fed into two 450-foot-long rotating, almost horizontal, kilns. These have fire brick lining and chains to lift up the slurry as the apparatus rotates.

Coal is the fuel used for the heat in the kilns. It is a fine powdery coal blown into the tube at one end. Because it is so fine it ignites immediately and burns like gas. When both kilns are operating, 500 tons of coal are required each day.

In the first part of the process the moisture is driven off and the slurry heated to 1000 degrees F. Carbon dioxide is driven off farther on in the kiln. As the material nears the front, the temperature is about 2700 degrees and the chemical fusion of the lime, silica, iron and alumina takes place. This white-hot material is then cooled with air blasts to form a "clinker," in appearance like broken particles of mud.

The burned clinker and a small amount of gypsum are fed into still another large mill which is charged with 100 tons of steel balls up to three inches in diameter. Here it is again finely ground—virtually all will pass through a 200 mesh screen. The feed into the mill is controlled by an electric ear which responds to the noise of the balls as they encounter or fail to encounter the clinker.

The finished product is cooled and goes to pneumatic pumps where air is forced into the dry cement and it is pumped into silos for storage and subsequent shipment.

A special cement mixture has been developed recently which expands and contracts with weather cycles of heat and cold. A pine resin is added which traps air pockets. This is termed air entraining cement and is particularly useful for large outdoor surfaces. Because gypsum controls the setting up of the cement, varying amounts are added for quick set or slow set.

About 20 percent of the product is shipped in bags, the remaining 80 percent in bulk.

The plant is amazingly well equipped with controls and laboratories. It is also regarded as one of the safest of mines.

Water is obtained from Jonathan Creek for spraying within the mine. As it is fed back into the stream, which has evidence of acid mine water, the lime waste water blends and neutralizes the stream below.

Electrostatic precipitators have been installed to remove the particulate matter from the fossil fuel-fired kilns. The material is blown back into a portion of the mine no longer in use.

Fringe benefits for the 250 people employed at the plant cost the company $190 per month per employee. In addition to insurance, education, and retirement plans, these include areas and programs for recreation which seem to add to the good rapport within the organization.

Tours are limited to high school students. Arrangements must be made well in advance. Contact: Public Relations Director, Columbia Cement Company, East Fultonham 43735, phone: (614) 849-2311.

COLUMBUS AND SOUTHERN OHIO ELECTRIC COMPANY CONESVILLE GENERATING STATION

Location: Off SR 16, South of Coshocton, at Conesville, on the Muskingum River.

The Conesville Station is situated on the flood plains of the Muskingum River a few miles south of the confluence of its two large tributaries, the Walhonding and the Tuscarawas. Although the patrons of the light company are in central Ohio, the plant was located here because of direct access to a coal stripping operation for fuel and the Muskingum River for water. The operation began in 1947 with three units which include a furnace, a generator and a transformer for each unit. Land underlain by coal was purchased by the company and a conveyor belt, seven miles long, was constructed to bring coal from the mine to the plant. The Simco Mining Company, a part of Peabody Coal, performs the stripping operation.

Unit four, jointly owned with the Cincinnati Gas and Electric Company and the Dayton Power and Light Company, was completed in the spring of 1973. This plant is very modern with an electrostatic precipitator and cooling towers required by federal and state regulations. The stack is 800 feet high, as compared to the 450 foot chimneys for the units constructed earlier.

Pilings for the construction of units five and six were installed in the spring of 1973. This additional section of the plant will have the precipitators and cooling tower as well as a sulphur removing device. Eastern Ohio coal is high in sulphur and ash content. The No. 6 coal, or Middle Kittaning, the coal which is mined here, is reported to have a sulphur content varying from as low as 2.03 to as high as 5.36 in Coshocton County. By contrast, coals used by the Dayton Power and Light, where scrubbers are not needed, have a .75 sulphur content. The ash is removed by the precipitators but the oxygenated sulfur gas must be processed through lime scrubbers to remove it from the gaseous material passing into the atmosphere. The Columbus and Southern Ohio Company is the first in the area to agree voluntarily to construct this device. Present (April 1973) regulations do not require it.

Water for both cooling and for making steam to drive the turbines is taken from the Muskingum River. The water is drawn into the generating station through screens which sift out fish and foreign matter. Before going to the condensers the water is purified in order to prevent growth of plant life and deposits of mineral matter which would otherwise collect in the tubes. After one time through the pipes to condense the steam, the cooling water is returned to the river a few degrees warmer. The steam water, which passes through a treatment plant making it more pure than distilled water, returns to the furnace to be reused time after time. An average generating station must have 400 million gallons of water a day just for condensing the steam.

Few men seem to be working in the generating plant. Most of the work is done automatically. An impressive control room with lights, charts and dials is attended by a few operators who can look into the huge furnaces by means of a television camera. They watch the dials to be sure all parts are functioning and to check the output of each generator. Safety controls are at their fingertips.

As a point of interest, 35 watts of electrical energy could be produced by one man in one day. If a generator produces 125,000 kilowatts (125,000,000 watts) the electrical energy it generates would be equivalent to the muscle power of 3,571,428 men (*Living with Electricity*, Columbus and Southern Ohio Electric Company, 1967).

A trip through the plant gives students an opportunity to see the coal as it goes to the top of the beaker house on an inclined belt where it is broken into small pieces. It flows by gravity through a crusher onto a second inclined belt which carries the coal to be weighed. Below the scales are pulverizers which grind the coal to a powder as fine as face powder. It is then mixed with preheated air and blown into the furnace where it ignites immediately because it is so fine. Thus its energy is released to heat water as the water circulates in tubes lining the inside of the furnace wall. A steam drum separates the water from the steam which then flows into a network of tubes where it is superheated to 1000 degrees F.

The steam, under high presure, strikes blades in a turbine with tremendous force. The spinning of the blades turns a shaft which makes magnetic lines of force to spin between coils in an armature. The outer edges of the turbine wheel travel more than 800 miles an hour — 100 miles an hour faster than sound travels.

The electricity from the generator flows through a transformer which consists of a soft iron core and two coils of wire. As the electricity flows through one coil, the core is magnetized. The alternating current of coil one and the resulting magnetic field induces the current in a second coil. The voltage produced in the second coil depends on the ratio of wire wound on coil one. Electricity coming from the transformer at 13,800 volts from the generator would be increased to 69,000 volts if coil two has five times as many windings as the first coil. Transformers can also decrease the voltage by reversing this procedure. The electricity is stepped up by transformers in the substation beside the generating station and stepped down by transformer at distribution points where electricity is delivered to consumers after being transmitted over long distances. Insulators are placed on the steel towers and wooden poles so that the electricity will not flow from wire to wire

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or down the poles to the ground. Circuit breakers switch off current in case of emergency and lightning arresters are installed to protect equipment when lightning strikes a substation. If lightning strikes a line, conductors carry the extra current to the ground.

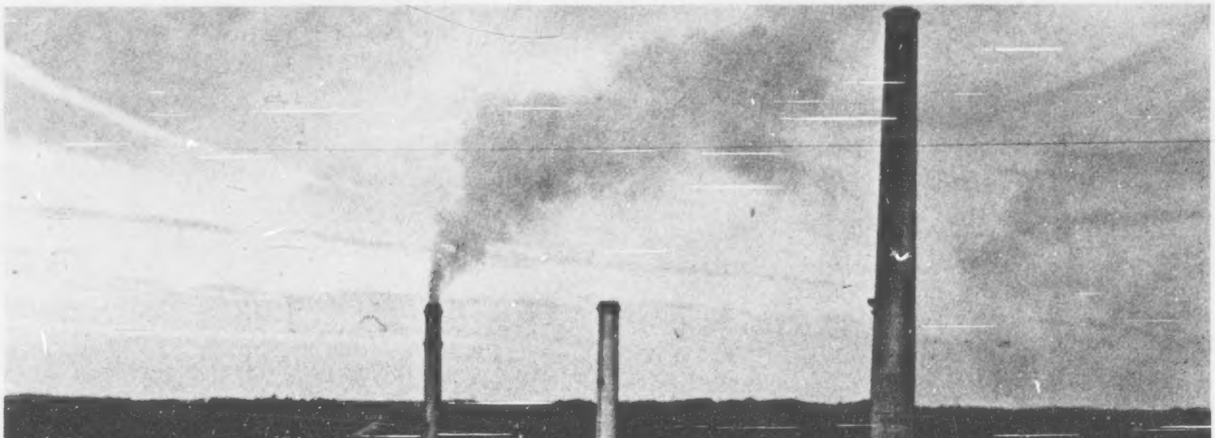
The coal stripping operation required to generate electricity in this plant is typically devastating to the softly rolling hills of the countryside. Much of the area had been cleared for farming and then was abandoned prior to stripmining. Hundreds of acres have been reclaimed successfully. The company has given 500 acres for a Boy Scout Reservation which now has extensive green rolling hills similar to its earlier topography. Black gob piles and yellow waters indicate places where there has been deep mining. Parts of the stripped land near the present operation are being reclaimed under the old law. Contours and planting show a definite effort to exceed the requirements. The section newly stripped has bulldozers working to return the rock rubble to the wall in compliance with the new law.

The new unit with its electrostatic precipitator and cooling towers met air and water quality standards in 1968, when it was designed, although emissions at the present time do not meet updated air standards. Modernizing the old units is a real problem which is under study.

Water returning to the river is monitored by the state health department daily. The few degrees' rise in temperature of the returned water seems to have little effect on fish and fishing. This situation, too, is being studied.

A large sludge basin receives the ash residue. Its presence on the landscape is another trade-off for the inexpensive power provided for the company's customers.

More complete description of the process at the plant and the controls and devices necessary to carry the current to homes and industries, how to read meters, and safety measures can be found in the reference cited above. Copies may be obtained prior to the visit for class study. Requests for films to be shown as background information may be made. Arrangements must be made three weeks prior to trip. For obtaining the booklet and films and arranging for a tour through the plant and the strip mine area, contact: Supervisor of Educational Activities, Public Relations Department, Columbus and Southern Ohio Electric Company, 215 North Front Street, Columbus, Ohio 43215, phone: (614) 228-6411 Ext. 366.



Conesville Generating Station on the Muskingum River

EASTERN OHIO RESOURCE DEVELOPMENT CENTER—UNIT II

A Branch of the Ohio Agricultural Research and Development Center. Location: off I-77, eight miles southeast of Caldwell bordering SR 564.

The purpose of this study is to present several kinds of reclamation practices being experimented with. A tour through the extensive strip-mined area of 1326 acres, some mined recently and some in 1965, gives a comprehensive picture of the aesthetic, erosional, water and revegetative problems which are associated with the disruption of the land because of the surface extraction of coal. A one-day field trip for the broad picture or a series of visits for study and testing could be valuable for earth science, chemistry, physics, social studies, or ecology classes.

Lee Walp, professor of biology, Marietta College, in a strip mine field guide for the Ohio Academy of Science 1972 ecology field trip to this site described the history of the area in this way:

"The Mound Builders were the first occupants in Range 9, Township 6. Their culture was based upon sunflower seeds but records in the Hildreth letters (Samuel Prescott Hildreth, *Biographic and Historical Memoirs of the Early Pioneer Settlers in Ohio*, Cincinnati, 1852) bear out the fact that they and later Indian cultures burned the land in their exploitation of the game. White man exploited the wildlife, too, and the last buffalo was killed in the early part of the nineteenth century. He cut the trees in the central hardwood forests to expedite the clearing of land and burned the forests for the same reason.

"Following the depletion of large game and forests, the cleared land was found profitable only for grazing cattle . . . and sheep.

"Between 1814 and 1840, Seneca [Company] oil was being shipped to New Orleans as a vermifuge and a liniment. In a few years its value as an illuminating oil was discovered and this started the oil boom here. Since there was a transportation problem, the Buckeye Pipe Line Company was organized in 1883 at Macksburg, which was once a thriving community.

"The last resource to be exploited was coal, and strip mining started soon after World War II."

Surface mining, now practiced in 22 states, has increased dramatically since 1940. At that time the strip mining method produced about 9.4% of the total U.S. coal production, while in 1970 strip mine production amounted to 44% of the total. According to a report by the National Coal Association, the 1970 surface mining production is the equivalent of about 28% of the total electrical energy output of the United States. (Charles V. Riley, *Design for Criteria of Mined Land Reclamation, Mining Engineering*, March 1973.)

Dr. Riley further states, "The key to a successful reclamation program actually begins with a basic knowledge and appreciation of the geology and chemical characteristics of the overburden." *(Ibid.)*

The Eastern Ohio Resource Development Center is operated as one of the branches of the Ohio Agricultural Research and Development Center at Wooster. During 1966 the OARDC received gifts of 1000 acres from the Union Carbide Corporation and 325 acres from the Baker and Noon Coal Company. This area is known as Unit II of the Eastern Ohio Resource Development Center.

The land lies in the unglaciated Allegheny Plateau region of eastern Ohio. The Pennsylvanian series of rock strata consists of shales, sandstones and coal, and in the Conemaugh, or middle strata, limestone. The coal mined in the Unit II area was the Meigs Creek or Number Nine coal of the upper Pennsylvanian series. The overlying rocks exposed in the highwalls in the area are largely sandstones and shales. Since the region was strip mined prior to the existing law and care in removing the overburden was not recognized as necessary for effective reclamation, the spoil banks consisting of this material are largely toxic to vegetation.

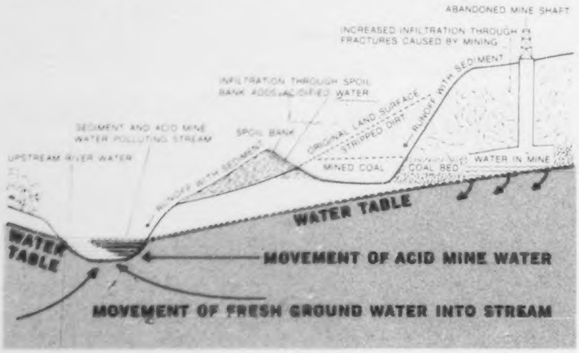
The field trip follows a widened and stoned road through approximately 300 acres of spoil banks which were contour strip mined in 1965 and 1966. A part of the area provides some pasture for a herd of beef cattle. However the cattle observed on the tour are in an enclosed non-vegetated area and feed is brought in. The spoil land is benefited by the presence of the animals because of the manure they leave. This is noticeable at the feeding station where vegetation is growing. Two farm ponds have been constructed for water supply. One is located so that the water can be used for spoil bank infiltration studies by the agronomist directing the research projects.

Water control and management are important aspects for consideration both during active mining and for land reclamation. Acid mine water drainage has been a hobgoblin for the fish and wildlife in a strip mine area and for those people who witness its effects upon the biotic communities. Though much of the present problem is due to abandoned deep mines, strip mined areas, too, have contributed to the pollution of the streams under certain conditions. The following diagram illustrates how acid mine drainage moves through the broken earth surface around old mine shafts and strip mine areas to enter the ground water moving into a nearby stream. Sediment from the bare, disturbed land and the spoil banks finds its way into the stream also, unless it is impounded in a settling basin or controlled by vegetation. The tour through the property shows the water problems, settling basins to help control one aspect, and revegetation efforts.

Strip mine spoils are basically the blasted and broken rock rubble removed from the top of the coal

CONTAMINATION OF WATER BY DRAINAGE FROM MINES

Acid mine drainage moves through fractured ground around old mine shafts and strip-mined areas to join the ground water moving into the nearby stream. Sediment from the disturbed areas and spoil banks adds to the pollution.


ABANDONED MINE SHAFT
INCREASED INFILTRATION THROUGH FRACTURES CAUSED BY MINING
RUNOFF WITH SEDIMENT
INFILTRATION THROUGH SPOIL BANK ADDS ACIDIFIED WATER
ORIGINAL LAND SURFACE
STRIPPED DIRT
SEDIMENT AND ACID MINE WATER POLLUTING STREAM
SPOIL BANK
UPSTREAM RIVER WATER
RUNOFF WITH SEDIMENT
MINED COAL
COAL BED
WATER IN MINE
WATER TABLE
WATER TABLE
MOVEMENT OF ACID MINE WATER
MOVEMENT OF FRESH GROUND WATER INTO STREAM

seam by giant draglines or shovels. The geologic formations broken up to form the spoils contain the minerals which determine the toxicity of the spoil. The slope of the land is a factor related to the ability of the rubble to retain precipitation, and the stoniness or coarseness of the material influences the reclamation process. The spoil is composed of various sizes of rocks, shale fragments, sand, silt and ground up clay particles. Shale is generally recognized as the source of the acid material, and the sandstone associated with the shale is a provider of pollutant metals found in the acid runoff. During strip mining, iron disulphide (pyrite) found in the shale is exposed to the air and reacts with oxygen and water to form sulfuric acid and ferric hydroxide. The acid reacts with other minerals in the spoil so that aluminum, manganese, calcium and magnesium salts are brought into solution and enter the stream flow.

The revegetation of this rock rubble in the research area has been difficult because 75 percent of the material has a pH under 4.0 (high in acidity; 7 is neutral).

It is high in pyritic material, and while successive leaching by rainfall and normal weathering remove excessive quantities of the mineral salts mentioned above, this is a slow process and erosion is rapid.

During the trip through the property, sites may be visited where the application of lime to neutralize the acidity has been tried. A post hole digger was used to dig holes approximately 10 inches deep, with a diameter of seven inches. Limestone in varying quantities was mixed with soil and put into the holes. Tree seedlings were transplanted. The plants grew, but when the root systems came into contact with the toxic spoil the trees became stunted.

In two areas sludge material from the wastewater treatment plant in Caldwell has been used on large plots. Since there is no soil profile for normal percolation, and the material lacks nitrogen, phosphorus, organic matter and micro-organisms which are necessary for plant growth, treated sludge should be able to supply these materials. The program is being tried widely through the United States and may prove to be a method for solving two environmental problems. The long term results of this type of experimentation are not conclusive at the present time, but in areas where application of anaerobically digested sludge has been used on a large scale, the water quality and soil pH have improved and provided a healthy environment for vegetation on a small scale. (Terrence R. Lejcher, *Utilizing Treated Municipal Wastes for Stripmine Reclamation, Mining Engineering*, March 1973.)

At Unit II, sludge treatment has shown the best results thus far. The lush stand of rye indicates successful growth. The amount of sludge available from Caldwell is limited and demand by others is great. A new more extensive source is being sought.

The kind of vegetation for strip mine soils is an important consideration. Some trees survive in soil with a pH below 4.0 but do not thrive. European black alder, large-tooth aspen, river birch, cottonwood, black locust, red oak, pitch pine, shortleaf pine, Virginia pine, sweetgum and sycamore are in this category. (Robert R. Paton, *Tree Planting Guide for the Reclamation of Strip Mine Lands in Ohio*, published by the Ohio Reclamation Association, Bull. No. 70-1, June 1970.) These and a wider variety of species will grow on soils with pH 4.0 to 5.5. Bristly locust planted on slopes in four places has shown the best growth on the Unit II spoil banks.

Experiments were made on 10 foot plots with legume (nitrogen fixation) plants and grasses such as Kentucky 31, fescue, sweet clover, Korean lespedeza, orchardgrass, and birdsfoot trefoil planted in soil materials covering the spoil to depths of two, four, six, eight and 10 inches. No plant growth was obtained on the two inch depth. Lespedeza and fescue were the predominant plant species that grew, but none were found growing into the toxic soil. Other parts of Ohio where slope is negligible and the acidity has been counteracted show successful growth of these two species on extensive sites.

Apple and peach orchards on unstripmined hilltops give a great contrast to the bare problem area. A few natural woodland plots remain also to remind researchers of the natural vegetation pattern.

The research director is frequently available to guide and interpret the area to students. The study is recommended for high school classes only.

A little roadside park is available on the property or groups may wish to take advantage of Wolf Creek State Park facilities just north of the area. Contact: Research Director, Eastern Ohio Resource Development Center, Caldwell 43724, phone: (614) 732-5190.

FLINT RIDGE STATE MEMORIAL

Location: The total area of Flint Ridge extends five to six square miles and is over seven miles in length. The ridge is a portion of the rugged hills located in eastern Licking and western Muskingum counties about midway between Newark and Zanesville. The 518-acre Flint Ridge State Memorial is located in Licking County on SR 668 north of Brownsville. In the literature it is often referred to as the crossroads.

The flint that is found on the ridge is of the Vanport member of the Allegheny series. This deposit was formed in a quiet marine environment either by the accumulation of siliceous organic matter or direct precipitation. Elevation of the strata occurred in the Permian Period 200 million years ago.

The flint deposit depth varies from one to 10 feet with an average thickness around five feet. Some of the thickest deposits and those of the best quality are found in the vicinity of the state memorial. The deposits are sometimes covered with as much as 15 to 20 feet of topsoil which aids in protection from weathering.

The properties of flint give hints to its usefulness. It is hard; it is rated seven on the Moh's hardness scale; it can easily scratch glass; and it is not affected by steel. It breaks with a pronounced conchoidal fracture that leaves a sharp cutting edge. Primarily flint is composed of silica (96.4%); however, impurities such as iron produce the varieties of colors found in the flint.

The history with respect to man's use of the area is long and vivid, starting with the prehistoric Indians. The Indians used the flint to make implements such as hoes and skinning knives and weapons such as spearpoints and arrowheads. It has been hypothesized that no fighting took place at Flint Ridge. It was neutral territory for all to mine the raw material that was in so much demand.

It was found that the flint exposed to weathering was useless. Beneath the surface, the quality of flint was much better. Therefore, quarrying was done in large deep pits. Remnants of these pits are seen in the area. The Indians would take blocks of the mined rock several yards away to fashion it into the articles needed. Evidence of worked flint, chips and cores, can be found at the sites the Indians used for their "finishing shops."

When the pioneers settled in the area, they too discovered the usefulness of flint. Flint was used to produce a spark to ignite the powder charge in the old-fashioned flint-lock muskets that were in general use at the time. Larger pieces of flint were used to spark the tinder for cabins and campfires. In the early 1800's, flint debris in the area was hauled away to form part of the National Road. Buhrstones used for grinding were also fashioned from a porous type of flint found at Flint Ridge. In 1965 flint was adopted as Ohio's official gemstone. Today attractive jewelry is made from the multicolored rock.

Besides flint, the ridge had some other useful raw materials which included coal and clay. Cannel coal was mined one mile west of the crossroads. This coal contained a high oil content which caused the coal to burn readily with a long smoky flame. Supposedly a pottery operated on top of the ridge using fire and stoneware clay that was found nearby as its raw material.

Fallen logs and standing snags suggest the once magnificent chestnut trees' presence in the area. Now most of the woods contain principal species of oaks and hickories. However, the plant associations at Flint Ridge are varied. Stands of maple and some beech can be seen. Bigtoothed aspen are also observed in select spots. The herbaceous vegetation has much variety and is interesting to observe.

Historically, bobcats and bears were found at the ridge. Today chipmucks and squirrels can usually be seen darting around in the woods. This is especially true in the fall when collecting season is at its height. Not too infrequently one may see evidence of a frequently traveled deer path. Woodpeckers pecking, hawks soaring, and other birds chirping are signs of the bird life of the area.

The state memorial was formed in 1933, when 25 acres in the vicinity of the crossroads were given for public park purposes to the Ohio Historical Society. The cornerstone of the shelter house, which is no longer standing, was dated 1935. Later additional land was acquired.

In 1968 a modern museum opened which contains a flint pit, demonstrates probable techniques of flint chipping, tells the geology of the area, and displays artifacts and jewelery made from flint.

Approximately three miles of nature trails taking one past flint pits and through wooded areas of the park have been constructed. In the spring of 1972, a specially designed nature trail for the handicapped was opened. The trail has a blacktop surface and a guiding rope. The slope is minimal to accommodate wheelchairs. Interpretation signs are written both in English and in Braille. Specimens are close at hand to be touched and felt. The trail meanders 1,100 feet through a wooded area near the museum.

Picnic tables, water fountains, and restrooms are available to the visitor. Visitors are requested to refrain from taking pieces of flint. Contact: The Ohio Historical Society, I-71 and 17th Ave., Columbus, Ohio 43211, phone: (614) 469-2919.

NELSON McCOY POTTERY

Location: off SR 93 south of Zanesville at Roseville.

This field trip gives a basic understanding and appreciation of one of Ohio's early industries using local raw material in the form of clay and coal or gas to produce a product for daily use and home decoration. The local clay products are no longer regarded as satisfactory, and the minerals are obtained from areas as far away as Georgia, an interesting development in resource management.

The history of pottery making is as ancient as the appearance of man. Early prehistory cultures in this country and in other parts of the world fashioned clay as they found it in river beds to form articles needed in their everyday life. As a result, pottery of the Hopewell Indian shows a similarity to the pioneer American, or Chinese or Egyptian. Where preserved it shows a ruggedness, directness and simplicity which were usually lost as soon as civilization reached the point where need was less demanding and tools and techniques improved. It is interesting to note that the pot maker, prior to the invention of the pottery wheel, was a woman. Frequently throughout the history of tribes certain families established a pottery-making prerogative and any infringement meant trouble.

The terms pottery and porcelain both refer to ceramic ware; pottery is usually typical earthenware or stoneware, formed directly from native clays. Fine porcelains, often from France and China, appeared in the 1700's. These are strong vitreous, translucent ceramic material biscuit fired (fired to harden the body) at low temperatures and glass fired at a very high temperature. The raw material was largely a refined kaolin clay. A semi-porcelain ware is described as any of several vitrified ceramics lacking the translucency or hardness of true porcelain but otherwise similar to it.

In the United States many pioneer potteries were established by the early 17th century. There are indications that potteries existed in Jamestown, Virginia, at the time of Captain John Smith. The first pottery known west of the Alleghenies was built at Morgantown, West Virginia, about 1784. The first commercial scale white ware from china clay was made in 1860 at East Liverpool, now one of the great pottery centers of the world.

At the end of that century ceramics as a scientific industry came into being through the efforts of Edward Orton, Jr. This grandson of the first state geologist, who followed the family line of state geologists, succeeded in gaining sufficient support for a law authorizing a ceramics department at The Ohio State University in 1894. It was the first school for the scientific study of ceramic engineering. Shortly after, the New York State College of Ceramics was established at Alfred. Thus ceramic knowledge left the stronghold of family secrets and became a full blown modern industry.

The history of the Nelson McCoy pottery began at Zanesville 125 years ago. W. Nelson McCoy erected a small log building and began making stoneware, crocks and bowls. He stored them until spring when he could hitch up a team to his pot wagon and take to the open road to sell to farmers and general stores. He took wares to New Orleans by means of his own raft down the Muskingum to the Ohio and on to the Mississippi River. He dug the clay from the hills and cut the wood to be used in his kilns. His son, J. W. McCoy, built a pottery in Roseville and produced noteworthy lines of art pottery. The factory is now owned and operated by the Brush Pottery Company in Roseville.

Maintaining the craft and the family tradition, Nelson McCoy, a grandson, built the present pottery, producing stoneware such as meat tubs, butter crocks, mixing bowls and jardinieres. The latter product became so well known that the plant became a leader in the line. As the years passed improvements were made in the kilns and the dryers; cast work was initiated.

The pottery, considered to be the second oldest in the country, presently manufactures 1500 varieties of ware. Production is over 40,000 pieces a day in gas fired kilns. Nelson McCoy, Jr., the fourth generation of the pottery family, has been president since 1954. The plant recently was sold to a large corporation, Mount Clemens Pottery, which makes progressive growth and expansion possible, but McCoy remains as its president.

Groups may guide themselves through the plant following a chart designed to show the major stations in the operation. A guided tour by a ceramic engineer may be requested. With her help the trip can include an examination of the raw materials, which are no longer dug from the hills but are shipped in to make a whiter, finer pottery.

Fifty percent of the raw material mixed for the white artware now produced is kaolin and ball clay. Kaolin is ordinarily the decomposition of aluminous minerals, especially from the feldspar of granitic or metamorphic gneisses. The mineral for this plant is obtained from Georgia. Kaolins or china clays are the purest, whitest and most expensive clays. Ball clays are good quality, sedimentary, plastic refractory clays of limited distribution. They are added to the white ware to supply plasticity and high bonding qualities. Ball clay is procured from Kentucky and Tennessee.

The other ingredients of the mix are silica or "potter's flint," obtained from the nearby Glass Rock plant, added for strength; talc for thermal expansion; a deflocculent; and sodium silicate, which breaks the bonding of clay to make the mixture fluid like heavy cream. Nepheline syenite, primarily an alkaline feldspar rock low in silica, is added because it melts at lower temperatures. Whiting, a limestone product, and stonalite, a dolomite from Ohio composing four or five percent, give a fairly porous body to the finished product.

The ball clay is finely ground in a rotating mill. Water is added to the dry mix and the mixture is stored in tanks below floor level until it is needed. It then goes to a machine which dries it to the right consistency, which is like molding clay, de-airing the mixture by means of a 28 pound vacuum. Then it is cut into pieces and goes to a ram press, a jigger machine or a casting machine, depending on the kind of pottery to be made. From these operations the formed objects go to a circular drying unit, then to a glazing area. Here they are dipped, sprayed and then sent to the decorators who apply decals or paint on designs.

In this plant there is but one firing process, although most plants fire once before glazing and one time after glazing. The single firing reduces the cost unless a higher percentage of the ware is unsatisfactory after the single process.

As the thousands of objects are molded, dried, glazed and decorated, they are placed on huge racks on wheels and moved to the Harrop tunnel kiln which is 340 feet long and fires at 1970 degrees F. Kiln cars go in every 25 minutes in constant succession and the cycle is completed in 18 hours. The cycle consists of a gradual heating process up to 2200 degrees, after which there is a gradual cooling process.

As the cars emerge from this fiery furnace, the fusion of the minerals has taken place and the ware is ready for storage and shipment. Cookie jars, planters, pitchers, mixing bowls, mugs, steins, jugs and many other articles are on their way from coast to coast.

Water is used only in the mixing. It is obtained from the city system. Drying and burning the ware means a high consumption of natural gas and electricity. During the winter of 1972, the company was required to convert one of its drying units to oil in order to conserve gas. The results are not quite as satisfactory, but the conpany must comply. The gas consumed per year is 150,000,000 cubic feet.

Air pollution within the plant would appear to be a problem because of the fine clay particles which are mixed or ground into the floor and thus circulated in the air. But officials state that air pollution is not a problem.

Recycling of materials takes place until the articles are fired. Then the broken pieces are used as landfill for an extended parking lot.

A retail store located three miles south of Zanesville on US 22 may be visited following the tour.

For tour guide service it is well to make arrangement well in advance. There is no limitation on age for tourist families, but school classes should be at the fifth grade level or above. Contact: Manager, Nelson McCoy Pottery Company, Roseville 43777, phone: (614) 697-7331.

ROSCOE VILLAGE RESTORATION

Location: Off US 36 immediately west of Coshocton and the Muskingum River.

Few sites in Ohio provide a better example of reclamation and restoration. The little town of Roscoe across the Muskingum River from Coshocton had become a ghost of canal days; sturdy brick structures and white clapboard houses were unused and decayed. Like strip mines that need contouring and planting, water-filled gravel pits or urban ghettos, Roscoe until recently was waiting for something to happen.

In 1816 a village named Caldersburg after its founder, James Calder, was established at the present site of Roscoe. The name was changed in 1831 to honor William Roscoe, English poet, historian and abolitionist. When the 309-mile Ohio-Erie Canal was constructed, the village came alive and actually outgrew its sister city, Coshocton. Then the railroads were built through Coshocton, giving a great impetus to its growth, while canals, once such a boon to the people and the economy, were ignored and forgotten. Roscoe suffered the same fate.

In the late 1960's the Montgomery Foundation, representing community-minded citizens of Coshocton who envisioned a rebirth of the historic canal town, funded a restoration of the buildings and challenged the community to support the effort.

A restaurant with atmosphere and good food was a natural starting point. The sturdy old canal warehouse, once the lively scene of canal trade, was renovated first. With canal days atmosphere, either in gracious Victorian dining rooms or a rough beamed, hand-chiseled stone walled cellar, old-fashioned meals are served to tourists and appreciative citizens of the area.

The Williams House, the home of a canal era physician, displays fine antiques. The William Roscoe Building, a plain, sand-blasted, three-story brick structure which once housed the largest business in Roscoe, is now an apartment and office building which contains charming shops. A five-building group provides sites for the Roscoe General Store, book shop, cheese cellar, natural foods store, antique shop, hardware store, gift shop, art works and others. The restaurant and shops are served by people delightfully costumed in period style.

At the north end of Whitewoman Street is an antiquated, unrestored but completely captivating genuine blacksmith shop with a smith who might have walked out of a history book.

Township Hall is the recommended first stop. A slide show gives background information and literature and a map may be obtained. Guided tours are available by reservation only.

A delightful picnic area is just north of the village along the river. Triple locks were constructed at this park where the Walhonding Feeder Canal joined the Ohio-Erie Canal. It is difficult to imagine freight boats with products from Coshocton County's rich farms squeezing through the narrow walls of these locks.

In warm months of the year an authentic canal boat, Monticello II, takes a two-mile round trip on a strip of canal between Lake Park Basin and Mudport Basin. It is a memorable ride, a delightful glimpse into a colorful past.

A study of the area might include a visit to the Johnson-Humrickhouse Museum in Coshocton which exhibits oriental, European, early American, and Indian artifacts.

On August 21 of each year the citizens of the area commemorate the arrival in Roscoe of the first canal boat, the Monticello, in 1830. Canal era floats, drawn without benefit of mechanical vehicles, make a colorful parade while thousands of people dressed in costume enjoy the parade, old time music, lemonade, arts and crafts demonstrations and exhibits.

Like so many pioneer villages, Roscoe and its neighbor, Coshocton, were settled on the flood plains of major waterways. The advantages of river valley settlement were frequently offset by serious floods, as was the case here, where the Tuscarawas and Walhonding come together to form the mighty Muskingum. The area is now protected by two Muskingum Watershed Conservancy dams built on the Walhonding River.

During industrial expansion, plants were built on the flood plains both for water and transportation. New industries tend to follow the pattern. Stone Container Corporation lies across the river from Roscoe. Downstream are others including the Columbus and Southern Ohio Electric Generating Station at Conesville.

The village restoration project has given the people a new sense of pride in their historical background and an appreciation of its cultural value. The village provides modern, convenient housing, shopping and dining in an atmosphere of charm and enduring stability. The project has provided employment for more than 100 people. With thousands of tourists sharing the advantages of reclamation, the financial investment appears to be productive.

A field trip for observation and study is suitable for grades five through 12. For further information and reservations contact: Roscoe Village Restoration, 381 Hill Street, Coshocton, Ohio 43812, Phone: (614) 622-9310.

SIMCO COAL COMPANY

Location: In the vicinity of Wills Creek Dam at SR 76, seven miles east of the Columbus and Southern Ohio Conesville Generating Station.

The Coshocton County hills have been stripped of coal for many years. Hundreds of acres have been reclaimed under the old law. Some reclamation has been very successful. One property donated to the Muskingum Valley Boy Scout Reservation shows little evidence of its former devastation.

The land not stripped in the area has a rolling to steep topography. Some of it is under cultivation and much is returning by natural succession to meadow and woodland. The more rugged hillsides, particularly along Wills Creek, are covered with mixed hardwood forests and conifer plantings. Fishermen haunt the streams and birds are frequently seen. The villages appear to be little altered from the pattern maintained through many years.

Direction for the operation emanates from a simple office and equipment station a few miles from the present stripping site. The target is the No. 6 Coal or Middle Kittaning, which lies in the lower third of the Pennsylvanian Age series of coal seams. It is very thin-bedded in the area now being stripped but thicker in other places. The coal is soft, high in ash and sulphur content. Roadways are maintained at a contour interval about halfway to the hilltop. The land lying below this level is protected because the partially water-filled valley represents a tributary of Wills Creek above the dam and is part of the Muskingum Watershed Conservancy District property.

The trip through the area does not include actual contact with the high wall or the Big Chief shovel which does the greatest part of the work. The 1969 federal mine safety law requires that anyone near the mining operation shall wear a hard hat and hard-toed shoes. The high wall, rising 125 feet above the rock level where the coal has been taken out, is particularly dangerous, and the company thinks it is not practical to furnish safety shoes for a busload of students. The Big Chief removes 70 cubic yards of overburden in one scoop. After an area is cleared, the exposed coal is shovelled into trucks to be loaded upon the conveyor belt and carried to the Columbus and Southern Ohio Electric Generating Station at Conesville.

The conveyor belt, resembling a giant caterpillar winding its way through the hills, has proved to be a profitable means of coal transport. Constant maintenance is necessary — oiling, repairing and replacing parts. As the mining operation is extended farther away, additional lengths are added to the system.

The coal stripping operation is augmented with auger drilling at one site along the tour. This is a process where a device is forced with a rotating motion into the side of a hill where a coal seam is exposed. The coal is forced out as the auger is drilled in. This is a means of mining where the rock above the seam has become too thick for profitable strip-mining.

The rocky rubble strewn over the hillside and the towering rock walls which designate the mining contour are not lovely to the eye of anyone except perhaps a geologist. At present there are two patterns of reclamation being followed: the A License regulation, which permits the high wall and a 30° slope to remain, and the B License pattern which conforms to the 1972 strip mine law. In the areas contracted for prior to the passage of the present strip mine law, part has been reclaimed surpassing the law's requirements. The topography is gentle, and plantings of locust, sycamore, tulip and maple are growing well. On the B License land where the strip mine process has just been completed, caterpillar-dozers bring the rock rubble back to the high wall. Even with six of these large pieces of equipment costing $100,000 each, the work goes so slowly that a drag line has been ordered to expedite the process. The present equipment is estimated to cost $39 an hour, 24 hours a day, for each machine.

Erosion and stream sedimentation is a considerable problem in the reclaimed areas without complete vegetational cover as well as on the unreclaimed land. Settling basins are in evidence and give some measure of control. The presence of acid mine water is not always discernible.

This trip is recommended as a complement to the tour of the generating plant at Conesville. All the problems are evident but so are the efforts to remedy them. Students will be aware as never before of the trade-offs they make for the privilege of snapping on a light. This tour is arranged and supervised by: Supervisor of Educational Activities, Public Relations Department, Columbus and Southern Ohio Electric Company, 215 North Front Street, Columbus, Ohio 43215, Phone: (614) 228-6411—Ext. 366.

STARK WILDERNESS CENTER

Location: On US 250, one mile west of Wilmot.

As one of the few vestiges of the climax virgin forest in Ohio, the Stark Wilderness Center is "dedicated to preserving the best of the past through conserving the present." The magnificent beeches and maples that have lived quietly through two centuries of the ebb and flow of history, the still ponds, home of great diversity of miniature life, and the soggy marsh thick with fleshy vegetation, all provide rich opportunities to gain an awareness of the components of an ecosystem and how they interrelate, a message so critically needed with today's environmental crisis.

The Canton Audubon Society in 1963 conceived the center as a place to "learn but not to disturb." With enthusiastic broad-based support from public schools, business, industry, and private citizens, the Stark Wilderness Center, Inc., was born a year later. Soon the center bought 30 acres of virgin beech maple forest from the Charlie Sigrist estate in Wilmot. Most of the original trees remain because Sigrist realized their immense esthetic and educational value. Within a few years, the center grew to its present 409 acres.

Because of a tremendous two-year volunteer effort by local Boy Scouts, the forest was carefully cut to create several trails leading to a variety of natural environments. In the Spring of 1973, the center broke ground for a new interpretive building to house meetings, seminars, laboratory activities, and displays.

The pay-off today for these past energies is a preserve which serves thousands of children and adults annually.

The fruition of the Canton Audubon Society's dream provides one other crucial lesson: that only a concern for the environment, coupled with positive action, can save environmentally significant areas. Situated just beyond the most southern edge of where the ancient Wisconsin Glacier stopped in Ohio, this wilderness preserve has some very special attributes. In rambling through Sigrist Woods, a most impressive forest community, visitors can see and touch, for example, the largest of Ohio's red oak trees, "Old Red." Although it is hollow it stands straight and tall, dwarfing the elm, oak and walnut trees below it.

At a fork in trail, the granddaddy of the forest lies fallen. Ol'Burr, a bur oak 16 feet across, stood here when Columbus first came to America. Then on the forest floor below, in contrast, tiny violets cover some of the base of what was "Ole Burr's" trunk. In some places flowers grow so thickly they appear like purple stars on a green sea.

If the visitor stops to listen, a different world of sound can be heard in the gentle breeze catching the leaves in the forest canopy or a rabbit scampering through the leaves on the ground.

The Sugar Creek Trail passes along Sugar Creek that serves to quench the thirst of residents of the forest like the skunk, the opossum, and the raccoon. Green herons or the great blue heron might be seen at the pond down Trail Number 4. There is a living museum of tiny creatures in this pond, each a part of a complex food web that can be studied to understand our relationship with the rest of the food ecosystem.

The North Woods Trail offers a view of two communities, beginning with a woodland, then passing an abandoned farm, and back again to a woodland.

Each of these diverse communities, whether the Sigrist Woods, the pond, Sugar Creek, or the marsh area, offers vast opportunities to see the pieces of a natural community and discover how they fit together. The center's naturalists generally approach their education program by identifying the plant and animal "pieces" and their function in the total community. In their free guided tours, they will describe other aspects of the wilderness including the geological features of the Sugar Creek Valley, animal tracks, or the uses of the forest plants to early settlers and Indians.

The naturalists are trained to bring out the multidisciplinary nature of the environment, as it is a result of man's activity, geology, and natural succession. Youngsters can begin to see the variety of disciplines that explain their environment. With this experience and a knowledge of how to solve a simple problem, students can begin to take positive action to improve their environment. For example, knowing that the vegetation absorbs the moisture in the forest and is therefore a major deterrent to soil erosion can provide the basis for dealing with soil erosion problems in the local community.

The center also offers in-service training programs for teachers in addition to a wide variety of interesting outing possibilities for members.

The Stark Wilderness Center can handle as many as five classes at once. It operates year round and requires a few weeks' notice for guided tours. Contact: Naturalist, Stark Wilderness Center, Box 38, Wilmot, Ohio 44689, (216) 359-5117.

ADDITIONAL MUSKINGUM RIVER WATERSHED SITES

Allen Museum, Muskingum County, at Norwich off I-70 on the old National Road, contact: Rollin Allen, Norwich 43767, phone: (614) 872-3226.

An excellent collection of Indian ware and items of early America is owned privately but shared with interested students.

Ashland County Farm and City Tour, Ashland County, contact: Cooperative Extension Service, Courthouse, Ashland 44805, phone: (419) 322-4741.

The tour can include a number of stops at places pre-arranged. These may be the Bob Jackson farm with modern manure handling, Winding Brook farm showing automated feed mixing, Cinnamon Lake, a planned housing development, a poultry farm, an automated beef cattle farm, a sod farm, a sheep farm, a cider mill and a horse farm.

Avondale Wildlife Area, Muskingum County, near Maxahela Park on SR 93 south of Zanesville, contact: The Ohio Power Company, P.O. Box 328, McConnelsville 43756, or Division of Wildlife District Tour Office, 360 East State Street, Athens 45701, phone: (614) 593-6933.

This is a valuable site for observation of reclamation of many acres of stripped lands with ponds for aquatic study, plantings and natural woodland.

Camp Tippecanoe, Harrison County, located on north side of Lake Clendening off SR 8, contact: YMCA Camping Executive, 405 2nd Street NW, Canton 44706, phone: (216) 456-7141.

Rugged terrain along a quiet lake which is one of the Muskingum Watershed Conservancy District impoundments for flood control and recreation, this site provides study areas in water quality, resource management and land use.

Campus Martius Museum, Washington County, on corner of Washington and Second Street in Marietta, contact: Ohio Historical Center, Columbus 43211, phone: (614) 469-2919.

The history of Ohio's first settlement and the restored home of Rufus Putnam, its founder, may be a reinforcing experience for all age groups.

The Dawes Arboretum, Licking County, located 6 miles south of Newark on SR 13, contact: Educator Naturalist, Route 5, Newark 43055, phone (614) 345-2355.

Many natural and constructed habitats with 2500 woody plants including a cypress swamp, natural woodland and a famous collection of conifers and crab apple trees provide a learning experience with trained staff to help.

Dush's Christmas Tree Farm, Wayne County, located on Clinton Township Road 82, contact: Robert Dush, 2306 Grandview Avenue, Wooster 44691, phone: (216) 264-0099.

Reclamation of abandoned, unproductive land into a tree farm of conifers with a contrasting wooded area of numerous native hardwood species provides an excellent ecology and forest study area.

Fort Frye Research Farm and Environmental Center, Washington County, contact: Manager, Fort Frye School, Beverly 45715, phone: (614) 984-2376.

In a rather unique arrangement, the Fort Frye School FFA and an ecology group have been loaned 40 acres of farm and woodland for a variety of farm and natural area research. Students from other schools may participate.

Friendship Park, Jefferson County, located north of Smithfield off SR 151, contact: Jefferson County Commissioners, County Court House, Steubenville 43952, phone: (614) 283-4111.

This large strip mined acreage was given to the county to be reclaimed as a multipurpose recreation area. Reforestation and plantings of crown vetch and grasses are curbing erosion and providing habitat for wildlife. Excellent for reclamation and resource management studies.

Grace Haven Outdoor Education Area, Richland County, located off SR 13 south of Mansfield, contact: Educational Director, Rt. 5, Woodville Road, Mansfield 44903, phone: (216) 526-3749.

A wooded hillside with paths and trail guides indicating a wide variety of natural features has been developed as a school facility for Mansfield Christian School students and others who wish to use it as a study area.

Hall China Company, Columbiana County, on Anna Avenue in East Liverpool, contact: Public Relations Department, Hall China Company, East Liverpool 43920, phone: (216) 385-2900.

Students may take a self-guided tour to see dishes made from a variety of minerals combined by mixing and heating and molded into useful objects.

Harrison Reclamation Area, Harrison County, located 3 miles south of Jewett, contact: Ranger, Jefferson Reclamation Area, Route 1, Bloomingdale 43910, phone: (614) 264-5671.

This extensive strip mine area of 1321 acres was purchased by the state for reclamation and eventually recreation and nature study. The erosion, water damage, steep spoil banks—all the problems typical of strip mine land are available for study.

The Heart of Ohio Farm Tour, Knox County, a tour through the county arranged by the Cooperative Extension Service, contact: Cooperative Extension Service, Post Office Building, Mt. Vernon 43050, phone: (614) 393-1891.

A student bus trip with several stations for stopping may be arranged. Stops can include the Farmers

Exchange at Mt. Vernon, Knox County Airport, Knox County Landfill operation, the Kirkpatrick dairy farm, North Branch of Kokosing dam and reservoir, an engine museum, Apple Hill fruit farm, Amish school and other sites, as arranged by the tour service.

Hull Pottery, Muskingum County, located at 327 Amerine Street, Crooksville 43731, phone: (614) 982-2075 or 2085.

One of the long established potteries in the area which specializes in patio ware and florist planter line. The plant is extensive and highly mechanized.

Imperial Glass Corporation, Belmont County, 29th Street, Bellaire, contact: Public Relations Department, Imperial Glass Corporation, Bellaire 43906, phone: (614) 676-3511.

Pipeblown glass, hand pressed milk glass, crystal and colored glassware are hand crafted in one of the few remaining plants in the nation where glass is made by hand. The raw materials and processing are fascinating studies in resource management.

Inspiration Hills, Wayne County, in Congress Township on SR 604, contact: Director, Church of the Brethren Camp, West Salem 44287, phone: (419) 846-3010.

A well preserved forest area with rugged topography, a lake and conifer plantations make this site a delightful natural environment for ecological studies.

Kingwood Center, Richland County, located at 900 Park Avenue West in Mansfield, contact: Director, Kingwood Center, 900 Park Avenue, Mansfield 44903, phone: (419) 522-0211.

An outstanding array of plants suitable for the home garden together with a large pond with game birds, a natural woodland and open meadows provide a variety of experiences and ideas for home and school plantings.

Malabar Farm, Richland County, located 12 miles southeast of Mansfield near SR 95 and 603, contact: Manager, Lucas 44843, phone: (419) 892-2784.

The home of Louis Bromfield, noted author, farmer and conservationist is now operated by the Departments of Natural Resources and Agriculture. Wagon tours of the model farm, tours of the "Big House" and a look at the extensive library may be arranged.

Mansfield Weather Station, Richland County, location: on SR 13, south at Terminal Building, Municipal Airport, contact: Manager ESSA Weather Bureau, Box 212, Mansfield 44901, phone: (419) 522-7070.

A complete and interesting behind-the-scenes study of weather and weather instruments may be arranged.

Massillon Museum, Stark County, 212 Lincoln Way East, Massillon 44646, phone: (216) 833-4061.

For a look at history, art and science in one place this museum is available to school classes upon arrangement.

Mohican School in the Out-of-Doors, Richland County, location: The Wooster Presbytery Camp off SR 95 on McAurdy Road southwest of Perrysville, contact: Director, Box 150, Perrysville 44864, phone: (419) 938-8720.

The camp is a splendid setting for studying geology, soils, weather, astronomy, birds and other wildlife and natural woodland with the help of trained personnel.

Mt. Eaton Landfill Reclamation Area, Holmes County, located in Paint Township off SR 250, contact: Atlee Mullet, Berlin 44610, phone: (216) 893-1625.

Spoil banks resulting from strip mine operations are being used in part as sanitary landfill. Natural succession grasses and shrubs are providing cover. It is an interesting land use and reclamation project.

Muskingum River Electric Generating Station, Washington County, located 20 miles northwest of Marietta west of the Muskingum River near Beverly, contact: Public Affairs Department, Ohio Power, 301 Cleveland Avenue NW, Canton 44702, phone: (216) 456-8173.

Recent improvements to meet environmental standards add interest to this fossil fuel electric generating station.

Newark Wastewater Treatment Plant, Licking County, one mile southwest of the intersection of SR 16 and Dayton Road, contact: Superintendent, Newark 43053, phone: (614) 345-0549.

An activated sludge waste treatment plant equipped with incinerator, phosphate removal, and post chlorination treating 12 million gallons daily may be observed. Waste water is discharged into the Licking River eight miles above Dillon recreation area.

Ohio Power Recreation Area, Morgan County, access from SR 76-83 in northeast section of the county, contact: The Ohio Power Company, P.O. Box 328, McConnelsville 43756 or Division of Wildlife District Four Office, 360 East State Street, Athens 45701, phone: (614) 593-6933.

Remnants of original vegetation are intermingled with extensive reclaimed strip mine land available for a relationship study. Permits are required for anyone leaving the state highway.

Ohio Power Recreation Area, Muskingum County, along SR 284 and 340 in Meigs Township, contact: The Ohio Power Company, P.O. Box 328, McConnelsville 43756 or Division of Wildlife District Four

Office, 360 East State Street, Athens 45701, phone: (614) 593-6933.

Active stripmining and reclamation areas may be observed as well as Ohio's undisturbed hill country.

Ohio Power Recreation Area, Noble County, in the northwest portion of the county along SR 76, 340 and 215, contact: The Ohio Power Company, P.O. Box 328, McConnelsville 43756 or Division of Wildlife District Four Office, 360 East State Street, Athens 45701, phone: (614) 593-6933.

This section of the extensive reclamation area contains an information center with picnic facilities and a spur of the Muskingum Electric Railroad with a restored locomotive and cars on display. The reclaimed land is in several stages of development making comparisons and interesting study.

Old Town USA, Richland County, located 2½ miles northwest of Lexington, contact: Howard M. Young, Lexington-Ontario Road, Route 6, Mansfield 44903, phone: (419) 884-1507.

History comes alive to visitors of a reconstructed old time village which includes a one-room school, a general store, a post office, broomshop, barber and blacksmith shops and a jail!

Owens-Corning Fiberglass Plant, Licking County, on Case Avenue, contact: Director of Public Relations, Newark 43055, phone: (614) 345-3441.

High School students 14 years or over may arrange for a conducted tour of this very interesting operation as raw materials are combined to make fiber glass.

Richland County Farm Tour, Richland County, a number of tours in Richland County have been fall features for farmers. These may be arranged with the Richland County Soil Conservation Service or the Cooperative Extension Service as school tours for an understanding of agricultural resource management. Contact: District Conservationist, Soil Conservation Service, Mansfield 44905, phone: (419) 523-5159.

A suggested itinerary on the northwest part of the county may include the Spring Hill fruit farm, Reynolds peat operation, Foster's dairy farm, Swartz potato and onion farm, Naple sawmill, Bachrack beef cattle feeding barn, Warren turf nursery, Jones poultry farm and the Richland Chemical Company. Trips in other sections of the county may be arranged also.

Sally Buffalo Park, Harrison County, location: off SR 9 south of Cadiz, contact: Superintendent of Reclamation and Land Use, Hanna Coal Company, Cadiz 43907, phone: (614) 942-3116.

Revegetation of strip land around a lovely little lake with patches of native woodland provides a recreation site as well as an area to observe reclamation practices.

Scio Pottery, Harrison County, at Scio on SR 151, contact: Manager, Scio Pottery, Scio 43988, phone: (614) 945-3111.

Students may observe the process of converting raw materials into all types of dinnerware and/or visit a pottery museum.

Secrest Arboretum, Wayne County, on SR 76 one mile south of Wooster in the Ohio Agricultural Research and Development Center, contact: Forester, OARDC, Wooster 44691, phone: (216) 264-1021.

The arboretum emphasizes variety and naturalness in unique block plantings of forest trees, a rhodendron and azalia garden. A display of finished wood samples from all over the world may be studied in the laboratory building.

Shelby Municipal Water Treatment Plant, Richland County, location: on north Gamble Street, contact: Water Works Manager, City of Shelby 44875, phone: (419) 342-4085.

For an appreciation and understanding of the valuable resource water, for city use, a tour of this operation may be arranged.

Spangler Park, Wayne County, north of Wooster on Plain Township Road 4, contact: Manager, Friedlander Chalet, Department of Parks and Recreation, Wooster 44691, phone: (216) 345-7400.

One hundred acres of open park and mature woodlands with hardwoods, ravines, springs and wildlife species in abundance were donated to the city for multiple recreation and educational uses.

Stone Container Corporation, Coshocton County, located on North 4th Street beside the Muskingum River, contact: Manager, Stone Container Corporation, Coshocton 43812, phone: (614) 622-6543.

Tours may be arranged to see the process of paper making in a plant in existence since 1863. Recent anti-pollution installations will be of interest.

The Timken Company, Stark County, at 1835 Dueber Avenue SW, Canton 44706, phone: (216) 453-4511.

Timken of Canton is a large steel plant with steel bearing factories and steel tubing production. High school classes can see a good practical application for physics and chemistry processes. Resource management, air and water quality and energy uses are relevant issues.

Timken Company—Wooster Steel, Wayne County, located on Prairie Lane south of Wooster along Killbuck Creek, Wooster 44691, phone: (216) 264-1172.

A subsidiary of Timken at Canton, this large plant produces seamless alloy steel tubing. Periodic flooding of the capricious Killbuck Creek creates an environmental hazard for the plant. Age limitation is 14 years.

Wayne County Farm Tour, Wayne County, School Tours may be arranged through: The Cooperative Extension Service, 200 Vanover Street, Wooster 44691, phone: (216) 263-4730 or The Wayne County Soil Conservation Service, 2581 Cleveland Road, Wooster 44691, phone: (216) 262-2836.

Classes may visit the Ohio Agricultural Research and Development Center, strip cropping at the Canankamp farm, a horse farm, a dairy farm, a green house and a pheasant farm.

Warwick's Farm, Guernsey County, 2 miles south of New Concord, contact: Howard Warwick, Route 2, New Concord 43762, phone: (614) 826-4262.

A "Christmas tree" farm, planted 80 years ago, contains conifers and other trees and shrubs known in Ohio. There are excellent nature trails and a friendly host. Arrangements prior to visit must be made.

Willow Valley Farm, Richland County, on Crimson Road southeast of Mansfield, contact: Willow Valley Farm, Don Green, Owner, Route 4, Mansfield 44903, phone: (216) 589-4699.

Strawberries, 21,000 quarts of them last year, are the specialty of this farm. An excellent study in resource management.

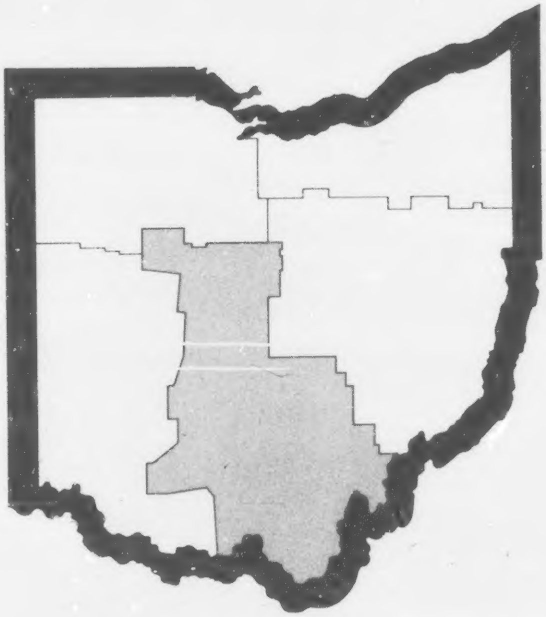
Zanesville Art Center, Muskingum County, location: 1145 Maple Avenue (and Adair Street), Zanesville 43701, phone: (614) 452-0741.

The primitive masterpieces, paintings, prints and sculpture are interpretations of environment and man's relationship to it. The museum is not open on Fridays.

Zanesville State Nursery, Muskingum County, on SR 666, six miles north of Zanesville, contact: Zanesville State Nursery, Gilbert Station, Route 5, Zanesville 43701, phone: (614) 453-9472.

The nursery is the source of seeds and seedlings of a variety of pine species, distributed to state properties for reforestation. A rich flood plain property, this site is valuable for resource management.

Scioto-Hocking Watershed Region



BACKGROUND INFORMATION

Biophysical Environment:
Gradation and transition establish an identity for this region, embracing twenty-two counties in central and southeastern Ohio. As one studies and compares a geologic, a glacial, and a soil map these transitions become evident. Union, Madison, Fayette and Highland counties lying west of the Scioto River are largely in the great till plains, an extension of the Little Corn Belt. In contrast to this flatness is the range of Appalachian foothills which swing from north to south on the eastern side of the region. The western counties are underlain by Silurian dolomite formations (magnesium limestone) and Devonian limestones. These are topped with a high-lime till plastered on the surface by the Wisconsin glacier. Then comes a transition in underlying rock strata where Mississippian sandstones east of the Scioto River hold up the first hills, with Ohio shale occupying an intermediate position between them and the flat limestone area. The change of rock strata is reflected in the soils, which are a low-lime till. The glaciers, obstructed by the foothills, penetrated only slightly into the counties of Perry, Hocking, Ross and Pike. The furthest extent of glaciation marks a more pronounced change in soil type. The parent rock material weathers in place and forms a thin, acid, residual soil. This is the growing material responsible for the beautiful hills in the Hocking watershed.

Mineral resources to be exploited from the bedrock and glacial deposits in the Scioto-Hocking region did not seem spectacular at the outset, nor were they responsible for early settlement. Indians had found the flint and saltlicks which were essential materials for living. Coal and iron were discovered and extracted in the Hocking Valley in Athens County, later in Jackson, Vinton, Meigs, Gallia and Lawrence counties. Although more abundant in other parts of Ohio, oil and building stone were important early developments. Lowly sand and gravel, glacial deposits along the meltwater streams, gradually became the basis for one of Ohio's great mineral industries. Conglomerates were quarried for a variety of purposes including the manufacture of glass sand and silica brick. Ceramic clays and fire clays in combination with the bituminous coal and natural gas were responsible for extensive industrialization throughout the Hocking watershed and north of it. The needs of a growing agricultural and urbanized state were to make these resources very important.

The Scioto River with its headwaters in Hardin County and its tributaries, the Olentangy, Big Walnut, Darby and Paint Creek, were originally glacial meltwater streams. Typically these show broad valleys and streams not big enough at present to have carved out the valleys they meander through. The valleys have been filled with extensive glacial deposits of sand and gravel. These deposits as well as the limestone bedrock aquifers in the northwest part of the watershed provide a readily accessible water supply for industrial development and urban expansion. In addition, the glacial outwash materials have been and still are excellent sources of building materials. Through the years, flooding has been a serious problem on the lower Scioto and Hocking rivers. A flood control dam on the Olentangy has so far been the only structure materially to control excesses on the Scioto. In spite of sizeable ground water reserves, reservoirs have been built on the Scioto, Big Walnut, and Alum Creek to meet the ever-increasing water demands of the City of Columbus.

The scenic Hocking watershed, originating in an old glacial lake plain in Fairfield County, runs its tortuous course through Hocking and Athens counties to the Ohio River. Encountering resistant parts of Blackhand sandstone of Mississippian age and others of younger Pennsylvania age, it creates rounded hills and steep walls covered in part by remnants of the beech and mixed oak forests typical of pioneer days. Because the Hocking is subject to flooding, the upper Hocking and its tributaries have become a part of a flood prevention watershed management plan which involves small dams, stabilization structures and conservation practices established by the Fairfield Soil Conservation District. Considerable channeling has taken place and the river has been divided at Athens to alleviate flooding on the normal flood plains where university buildings have been constructed. Efforts to dam Clear Creek, an outstandingly beautiful and biologically significant tributary valley, have been discontinued, at least for the time being.

Although acid soils are usually regarded as unproductive, the hill country is rich in plant and animal life. The deciduous forests covering the hills are particularly spectacular in the fall as the reds of sourwood, tupelo and sassafras mix with yellows of tulip and the dry oaks. Deep ravines with a northern coolness retain the glacial vegetation of hemlock and yew. Trailing arbutus, spotted pipsissewa, rattlesnake plantain, partridge berry, and wintergreen carpet many forest floors. Native magnolias, rhododendron, and laurel add considerable interest to the vegetation picture.

In addition to clearing for agricultural purposes, another tremendously disruptive factor during the early days of development was the use of wood from these forests to make charcoal. The charcoal then was burned in blast furnaces to process iron. Perhaps it is fortunate that Lake Superior iron deposits were discovered and this Ohio industry was discontinued. Wildlife in the hills is more abundant than elsewhere in the central Ohio region. The forested areas shelter deer and small mammals and a wealth of bird life. Wild turkey has been reintroduced at Waterloo Wildlife Experiment Station and is flourishing. Startlingly, it appears that poisonous snakes are still relatively rare within the glaciated region.

Socio-cultural Development:

Ohio's first human inhabitants, the Paleo-Indians, followed the movement of animals as the last glacier wasted back. It is highly possible man lived in central Ohio as long ago as 11,000 years. Several types of flint tools are attributed to these early inhabitants. By 6000 B.C. the cool post-glacial climate had become warmer and dryer. An "Archaic" culture replaced the Paleo-Indians which in turn, around 1000 B.C., gave way to the Adena culture which has left abundant evidence of its way of life. The conical burial mounds, the pottery, tools, tablets, bones and ornaments tell their story. The Adenas who stayed in central Ohio were absorbed by the later Hopewell people who are recognized as the most skillful of the prehistory inhabitants. Their complex earthworks and elaborate artifacts are evidence of their superior abilities. Little is known about their economic or social organization. They fashioned ornaments from copper and silver, probably carried as nuggets from the Lake Superior area. They used flint and salt from saltlicks on the Scioto tributaries.

Arrows, swords, axes and plowshares were important tools for the next episode in Ohio history. The Shawnee Indians, a fierce and warlike people, occupied the lower Scioto Valley. The Delawares settled in the Upper Muskingum Valley in the early 1700's, extending into the south and eastern sections of the Scioto-Hocking region.

French explorers were the first Europeans to enter the Ohio lands, primarily in the vicinity of Lake Erie, down the Maumee to the Wabash River; few found their way into the Scioto-Hocking region, although there was an early French settlement at Gallipolis ("city of the Gauls"). With the Treaty of Paris in 1763, which ceded all lands east of the Mississippi and south of the Great Lakes to the Colonies, settlement began.

Surveys, as authorized by Congress in 1785, and land grants were inducements for pioneer settlers. One tract, known as the Virginia Military District, lay west of the Scioto River and embraced a number of counties in this region. This grant was subdivided for veterans of the Revolution or for persons who encountered losses as war refugees. The settlers were primarily from Virginia until the 1850's. The names and the character of the enterprises still reflect this settlement pattern, and aerial photographs taken 150 years later show the persistence of survey and treaty lines in rural and urban areas. In addition to other agricultural pursuits there are four counties, Union, Madison, Fayette and Highland, which rank among top livestock counties in Ohio, again reflecting the influence of the Virginia settlers An exception to the Virginia influence is a community of Amish farmers in the flat lands south of Plain City. Their careful farming practices bear evidence of the fact that their forebears were from eastern Pennsylvania. A more extensive Amish settlement, however, was made in the Sugar Creek-Wilmot area (Muskingum Watershed Region) in the early 1820's. Other parts of the Scioto-Hocking Region lay in United States Military Land, Congress Lands or Ohio Company Purchase. Most of the last mentioned settlers were from Massachusetts and they attempted to make a living in much the same ways as in their homeland, by farming.

The middle counties in the Scioto watershed developed slowly but surely into a prosperous agricultural land. Columbus, although situated on the National Road, and on the Scioto River, lacked the impetus for settlement which prevailed in the land grant areas. Growth increased when it was selected to be the capital (1812), when the Ohio and Erie Canal system was developed (1831), and when the five railroads were built (1850). But Columbus was not to become industrial for many years. In 1860 its population was only 20,000; by 1951 it had reached 374,770. In 1973 it is the second largest city in Ohio with over half a million inhabitants. It has become a many-sided community, well balanced industrially, commercially and culturally.

Marion's development paralleled that of Columbus, tardy in settlement and manufacturing growth. The local invention of the hayrake in 1863 was the impetus to rapid development of many agricultural implements. Numerous other industries related to machinery manufacture, food processing and chemicals have made Marion a sizable city of 38,000. Delaware, home of Ohio Wesleyan University, has achieved some industrial importance as well as academic.

Other cities emerged along the Scioto River. Circleville, its original location on an ancient group of mounds or forts, was in the center of the rich Pickaway Plains and became a prosperous trading center. Modern Circleville has entered the industrial world with canneries, strawboard, and lighting equipment plants.

Although Marietta had become the seat of government in 1788, the constitutional convention assembled at Chillicothe and this settlement remained the capital through the first years of statehood. It became a thriving canal town after 1832 but lost its manufacturing industries when the canal failed. Since then it has hosted paper, shoe, and metal fabrication plants primarily.

Settlement began at the mouth of the Scioto in 1796, eight years after the first permanent settlers were established at Marietta. The first site, Alexandria, was abandoned in 1810 because it suffered severe flooding. Its inhabitants moved to a picturesque spot on the bend of the river known as Portsmouth. The canal in 1832 and later the three railroads, as well as the river packets and barges, were responsible for Portsmouth's rapid development. Sandstone bedrock from the area supplied material for many important structures in America, including Canadian government buildings. A bridge spanned the river in 1927. In 1950 a concrete flood wall was built to protect the city. Although the population was a rousing 40,000 people by 1940, the figure has declined steadily since then.

Ironton was built on the wide flood plain of the Ohio River at a later date, 1848. The rich supply of natural resources, iron ore, coal, limestone and fireclay as well as river and railroad transportation led to its greatest development in 1930. Population figures indicate a subsequent decline, but diversified industries have since led to population increase.

Lancaster in Fairfield County was settled by Germans from Lancaster County, Pennsylvania. The Pennsylvania Dutch influence remained strong for many years as successful farmers sought to duplicate the highly prosperous agricultural methods their forefathers had employed. A lateral canal connected Lancaster and Athens with the Ohio and Erie Canal; the Chesapeake and Ohio and the Pennsylvania railroads crossed and prepared Lancaster for a natural gas boom in 1887. Anchor-Hocking Glass and its subsidiaries as well as shoe manufacturing have provided a steady growth.

The movement of Negroes into Ohio was an interesting development in settlement. At the beginning of the Nineteenth Century, the Negro population in Ohio was less than 400. Because the original constitution denied Negroes the right to vote and further failed to guarantee them equal rights, the Negro question provoked discussion in any political campaign. Prejudice was as strong in Ohio as any place including the deep South, yet the Negro population grew steadily, especially in the Ohio and Scioto River valleys. By 1810, it totalled 1,890; by 1820, 4,723; in 1830 it doubled that number and a century later it reached nearly 310,000 due to World War I and the effects of the Industrial Revolution. Most Blacks settled in the urban areas, and although they still constitute the major group in inner city areas, the number of substantial and prosperous middle class Blacks in the state continues to grow steadily. (E.H. Roseboom and F. P. Weisenburger, *A History of Ohio*, Ohio Historical Society, 1953).

Man's Impact on the Environment of the Region: As pioneers, early settlers, and immigrants moved into this watershed region, population increased in great numbers and concentrated in urban and suburban areas. More and more land was cleared of its virgin forests, used for agriculture, manufacturing, extraction of minerals and urban development. Agriculture flourished in all parts of the two watersheds, but in the Hocking area considerable acreage has been abandoned as farmland and returned to forest by planting or natural succession. Almost two million acres of low-productive lands have been withdrawn for this purpose. Hocking, Ross, Meigs, Vinton, Jackson, Pike and Scioto counties contain great acreages of state forests, and Wayne National Forest maintains 113,000 acres for wildlife protection, forestry and recreation. An ever-increasing amount of land in this area and in the Muskingum region is being stripped for the extraction of soft coal. Flood plains along the rivers have been used for heavy industry and urban expansion. Much of central Ohio's high production farm land has been utilized for purposes other than agriculture. Population has actually decreased in some areas although it has grown in the cities farther north.

The increase in population and the rapid industrial development have placed high demands on energy production. The source of energy in this section of Ohio is coal, the most abundant fossil fuel. The amount of land disturbed by strip mining for coal and the number of power plants processing the coal for the production of electricity increase yearly. But the demands continue to grow. For obvious economic reasons the shallowest and closest-to-market coal reserves have been exploited most heavily. Costs will increase as deeper and more remote reserves are tapped. Environmental constraints in the form of the strip mine law, air and water pollution laws and their enforcement compound the complicated picture. A *Battelle Research Outlook* bulletin (*Vol. 4, no. 1, 1972*), "Our Energy Supply and Its Future," gives three broad, practical approaches to getting rid of the energy depletion spectre both for the immediate future and beyond:

1. Using today's major sources more efficiently or more intelligently.

2. Using more effectively today's available, but underused, sources of energy, for instance, the sun or reservoirs of geothermal energy.

3. Developing new sources of energy, or more efficient means of tapping or converting secondary sources, e.g., oil shale or tar sands.

The first and third approaches are practical for the Scioto-Hocking region.

The Scioto-Hocking region, which includes a long stretch along the Ohio River, has serious air pollution problems in 1973. Much may be attributed to thermal inversion, a weather situation where cold air is trapped at the surface by a blanket of warm air. Because the cooler air does not rise, the air becomes stagnant and the dispersion of contaminants ceases. Inversions are frequently nocturnal and are usually dissipated by noon as the sun rises and warms the cool layer of air. They may continue, however, for a day or two, creating a dangerous situation.

Industrial contaminants generally constitute about 21% of the total. (*National Air Pollution Control Report*, HEW 1968). Transportation pollutants provide twice as much, or 42%. Until cars and trucks have mechanisms to curtail pollution or are replaced by urban systems of transportation, high levels will continue in large cities and industrial valleys.

The river valleys in these two watersheds provide good water supply because of the extensive gravel deposits. The rock strata, however, as they change from limestone aquifers in the west to the sandstones and shales in the southeast, place severe limitations upon the natural ground water supply. Reservoirs continue to appear, although citizen resistance to stream impoundment is mounting. The major problem lies in the pollution of the streams by effluents from industry, agriculture and municipalities. Some acid mine water continues to drain into the waterways of this area, predominantly from abandoned underground mines. Severe sedimentation of streams occurs in stripmined areas, construction sites and lands farmed without good conservation practices.

It would seem that the rivers in this region need the development of a comprehensive plan comparable to the Mahoning River Basin Plan (See Ohio Environmental Protection Agency *Newsleaf*, January, 1973) which was recently approved and commended by the U.S. Environmental Protection Agency.

Like all other parts of the state, the Scioto-Hocking region has a critical solid waste problem. This runs the gamut from household castoffs through industrial material and old mine gob piles. Incineration and landfills constitute the major efforts for disposal. Landfills harmful with leachates draining into the waterways are not uncommon. Both may injure air and water quality.

Since the closing of open dumps became effective in 1971, many people in rural areas have resorted to illegal dumping along roadsides and streamsides. This is particularly true in the hill areas of southeastern Ohio. Devices for handling the situation demand community support and citizen interest in making collection boxes accessible. Cooperation of housewives in reducing amounts of waste and sorting and taking materials to recycling centers is greatly needed.

The new strip mining law with its stringent requirements for contouring, planting and guarding against acid mine drainage is far more significant for the Muskingum watershed than for the Scioto-Hocking region. This region has old mines with dumps or unreclaimed stripped areas and needs remedial measures. A further reclamation problem occurs in areas where sand and gravel have been taken out of river flood plains. Such pits are excavated below ground water level and provide ponds for potential recreational purposes although many of these areas remain unreclaimed.

Land use planning and resource management are the challenge of this region. Problems are not unique but the situations vary considerably from place to place.

"Land use planning for the future will be built on considerations of environmental quality as well as special topographic, climatic, economic and social characteristics of a region. The resulting plans will show the way for locating expanding industry, transportation and other economic activities and will determine residential patterns." (*Battelle Research Outlook*, "Cleaning up the Atmosphere," Vol. 2, No. 3, 1970.) It will include flood plain management, the wise use as well as production of energy, and resource management.

BARNEBEY CENTER

Location: In Fairfield County's Clear Creek Gorge five miles west of US 33 and south of Lancaster.

The purpose of this study is to furnish ecological information for a rich natural environment made available to the young people in Ohio. At present the center is used as an outdoor classroom for Ohio State University students in the School of Natural Resources, and for teacher training. Day field trips, even a series of them, to conduct seasonal or contrasting plot studies, are encouraged for neighboring school districts. Plans for the future include the development of facilities and staff to provide a resident outdoor education program for elementary school classes.

The widespread 985-acre outdoor educational facility was a gift to Ohio State from the late O. L. Barnebey, a Columbus industrialist with a love of nature and a desire to encourage it in others. He began acquiring land for a summer youth camp in Clear Creek valley in the 1920's. To the original 100 acres he added more tracts of land, constructed roads, built a large lodge, cabins and other facilities. He concerned himself at the outset with preserving the area in a natural state, supervising much of the construction and road building. With mules and a slip scoop, Barnebey provided for a lake.

In May, 1928, Barnebey's camp was dedicated as Camp Indianola, and for more than 40 years thousands of children and young people from area churches and other organizations enjoyed the facilities and nature-inspired programs of the Ohio hill location.

In later years the Barnebeys decided to give this much loved property to an institution which could even more fully develop its potential for a great environmental education center. It was dedicated in 1970 as Barnebey Center, the dedication attended by a host of interested and appreciative conservationists from all over the state. Since that time not only have many Ohio State Students enrolled in the Natural Resource 622 class which meets at Barnebey Center for 10 weeks during spring quarter, but numerous other colleges have conducted week-end field studies, and central Ohio schools have taken advantage of its availability.

Barnebey Center with its sprawling acreage is situated in south central Fairfield County beyond the edge of the furthest extent of glaciation in Ohio. The land has a rolling topography due primarily to the millions of years of erosion and the resistance to erosion of the Black Hand sandstone, the Mississippian period rock formation which lies beneath the surface. Clear Creek, fed by glacial meltwater, has dissected a deep and frequently narrow valley through the property and on down to its confluence with the Hocking River. Approximately 300 rugged acres lie across the creek and provide picturesque overhanging rock cavities and opportunities to observe the weathering processes affecting the various horizons in the Black Hand formation. Stream erosion and deposition, flood plain and terrace topography are important physical environment study possibilities.

In addition to geologic features which may be observed to advantage on many parts of the property, it is an ideal terrain for studying a variety of vegetation. The forested areas are a mixed mesophytic association with oak, tulip, beech, maple and hickory with hemlock in cool ravines and pine on the hilltop. Rhododendron and laurel are southern migrants, and the valley has typical sycamore, red elm, ash, and other flood plain vegetation. Birds are abundant and other animals may be observed in their protected habitats.

Students from the School of Natural Resources work in teams of six gaining practical experience in laying out nature trails, doing stream or lake studies or classifying trees. After orientation they work on their own with the three professors at the center advising and assisting. Ecologic research, nature interpretation, environmental analysis and management are encouraged.

The Clear Creek Gorge area is widely recognized as an unusual if not unique ecological situation. Other camps and study sites have been in operation for many years, each oriented toward preserving the natural esthetic and ecologic features. A long standing proposal by the Corps of Engineers to build a dam for flood control and recreational purposes met strong opposition when the plan approached the construction phase. The dam was deferred and at present (1973) a study is being made by the Bureau of Outdoor Recreation in the U.S. Department of the Interior to include the Clear Creek valley in a very broad national park program. Students of any age studying at the center have an opportunity to observe, hypothesize and assess values to the changes a program of this kind might make.

Classes engaging in a field trip, stream or plot studies at Barnebey Center provide their own leadership. Teachers are responsible for the learning experiences of the students. A trail guide and several unmarked trails may be used. Prior exploration and arrangements must be made. Contact: Barnebey Center Coordinator, The Ohio State University School of Natural Resources, 124 West 17th Avenue, Columbus, Ohio 43210, Phone: (614) 422-5589.

BUCKEYE FURNACE STATE MEMORIAL

Location: The Buckeye Furnace State Memorial was purchased by the Ohio Historical Society in 1935. Its 270 acres lie along Little Raccoon Creek, 10 miles east of Jackson and two miles south of SR 124 in Jackson County.

The Buckeye Furnace area is presented as a study in changes in land use and resource management which occurred as Ohio developed from small settlements to an agricultural and industrial complex.

Iron making came to New England with the early settlers and moved west with civilization. The difficulty and cost of transportation caused manufactured iron articles from the East to be high priced. Therefore, during the 19th century, there was great incentive in Ohio to develop a local iron industry.

The geology of the area is the key to the history of Buckeye Furnace. The area was adequately endowed with all the raw materials necessary for the manufacture of charcoal iron. To make one ton of pig iron required from 150-200 bushels of charcoal, 5,000 pounds of ore and about 300 pounds of limestone. The source of iron ore was found in a narrow vein of Vanport ore. Numerous deposits of limestone were present and hundreds of square miles of virgin timber were available to the early iron masters. There was also an abundance of sandstone with which to build and line the stone furnace stacks.

"Along the road west of Little Raccoon Creek in Section 26 near Buckeye Furnace, the thickness of the beds observed is given below:

Vanport ferriferous ore 4"
Vanport limestone 5′ 6"
Clarion coal 5′

Massive overlying sandstone, sometimes 30 feet thick, is found locally." (Wilbur Stout, *Geology of Southern Ohio*, Ohio Division of Geological Survey, Bulletin 20). These deposits are of the Pennsylvania system and the Allegheny formation dating approximately 290 million years.

The beds of ore were extensively used during the early period of iron making. Later some coal and coke furnaces used the ore. At present the ore is not being mined. However, one can easily hear the noise of nearby coal strip mining equipment at work, and coal haulers pass frequently on the township road that crosses the property.

The huge sandstone block furnace on the property was constructed in 1851 according to the date carved in the block of sandstone above the mouth of the stack. The blast furnace was fueled with charcoal. A blast of air from a waterpowered blowing engine produced sufficient heat to melt the ore with its limestone flux. The molten iron ran into a row of sand molds to harden. The red-hot iron was sometimes placed on an anvil and pounded with a power hammer to squeeze out excess slag. The iron could also be melted on an open hearth to remove excess carbon, then poured into sand molds to form skillets, kettles, and stove parts, among other items.

After most of the forest supplies in the area were depleted, the iron makers began to substitute coal to fuel some of the furnaces. However, the iron industry in Ohio was soon to fade out. Much of the iron made from the ore was off-grade. When improved methods of transportation permitted finer grade ores to be brought to Ohio from Minnesota, the industry became obsolete. Moreover, improved smelting techniques involving, for example, re-use of waste gases, rendered such small furnaces impractical. Most of the furnaces in the region ceased operation by 1900.

The Buckeye Furnace is under reconstruction by the Ohio Historical Society. Sheds for storing the charcoal, which had to be kept dry, for casting iron, and other equipment, have been rebuilt. The original sandstone block furnace stack is still standing.

The social-economic factors of the community found in the vicinity of each furnace make an interesting study. Living together would be several hundred people who followed the trades needed for operating and tending the furnace. These included laborers, teamsters, ore-diggers, blacksmith, bookkeepers, and the manager. Wages were low and life was primitive. Goods or script redeemable at the company store were usually paid as part of the wages.

The area is decidedly hilly due to the erosive action of the streams in the area. Steep slopes and bluffs are separated by small creeks. Some little brooks have rock bottoms, and the steep slope of the hills creates delightful little waterfalls.

The largest stream that runs through the area is Little Raccoon Creek. It is approximately five to 10 feet wide. The flood plain is fairly large. Its vegetation consists primarily of river birch and sycamore. Spicebush and buckeye are part of the understory and jewelweed and adder's tongue compose part of the ground cover. The water of Little Raccoon Creek has an orange color. The bordering vegetation also has this stain on it. This is due to the acid mine drainage of the coal mines in the region and the presence of iron in the area. The acid mine drainage has a definite adverse effect on the aquatic life in the stream.

The hillsides are forested with approximately even-aged trees dating back to the program of timber harvest to make charcoal for the furnace. Major species include several varieties of oak, some hickory, maple and tulip. A few young beech are observed. Wildflowers here include Dutchman's breeches, trillium, ginger, and spring beauties. On

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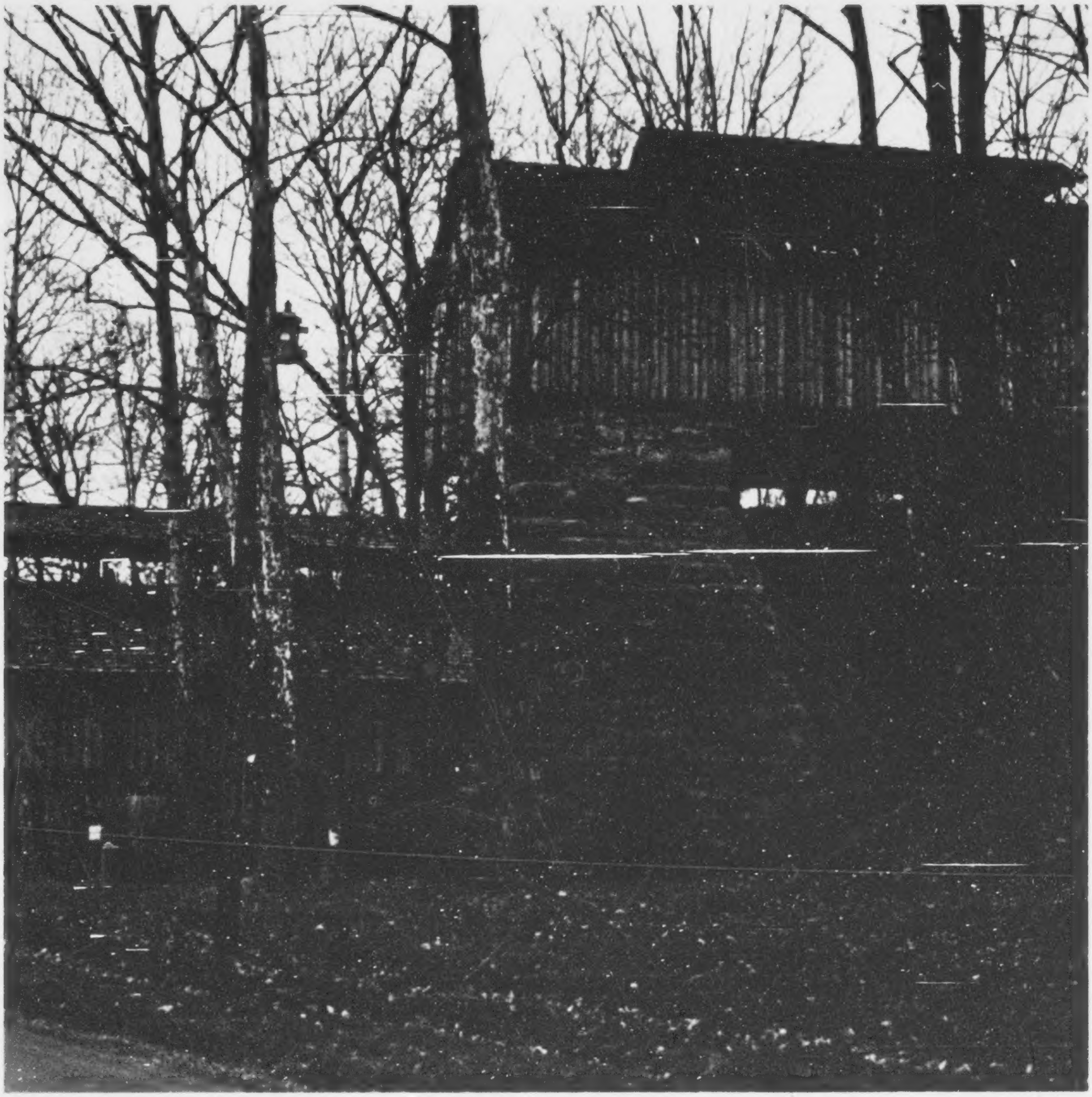
steep dry slopes moss and lichen are found as the ground cover.

At present there are no restroom or picnic facilities available at Buckeye Furnace State Memorial. These will be available in the spring, 1974. There is a two-mile nature trail through the wooded hills of the area. At present no interpretation has been done. Contact: The Ohio Historical Society, Ohio Historical Center, Columbus, Ohio 43211, Phone: (614) 469-2919.



Buckeye Furnace

CENTER OF SCIENCE AND INDUSTRY OF THE FRANKLIN COUNTY HISTORICAL SOCIETY

Location. In downtown Columbus at 280 East Broad Street.

The Center of Science and Industry is a cultural center housing exhibits and demonstration programs dealing with man, his industry, his environment, and his heritage. Eighty thousand square feet of exhibit space house privately sponsored exhibits and programs.

The exhibits and programs at COSI can be used to create interest, encourage investigation, and to reinforce previously developed attitudes. Annually over 250,000 students and adults (pre-school through golden age) gain insight into man, his world, and his impact on our total environment. The extent to which the exhibits can be relevant to any situation depends upon pre-visit activities, the visitation, and follow-up. The group program at COSI is designed to allow for exploration of exhibits, selective scheduling of demonstrations, and individual activities as planned by the teacher and students.

COSI has four basic areas of involvement which, if carefully evaluated, can add dimension to an understanding of the total environment.

Man himself, as an individual biological being, is explored in many ways. Exhibits depict reproduction from fertilization of the egg in models showing human birth and the anatomy of the heart, lung and teeth. Concepts related to the health of man make up the balance of the exhibits. The human anatomy story is told by a life-sized transparent talking woman. Films on human health, medicine, drugs and mental health can be scheduled. The Life Science Drug Exhibit houses live lecture demonstrations designed to explore the wonders of life and examine the menace of the "drug scene." Shows are geared to the age level of the audience and include "Understanding Life Processes," "The Effect of Drugs on Life," "Dangerous Street Drugs," "Understanding Human Mental Health." The impact of the total area helps to create an awareness of man's life processes and factors that affect life. Strong emphasis is placed on the normal healthy state of life.

The history area is dedicated to an understanding of Colonial America and our heritage. The Triumph of Man depicts 12 time periods in the history of man to show steps in his social and technological evolution. Scenes include The Dawn of Thinking Man, Control of Environmental Forces, and Cultural Interaction of Men. The Street of Yesteryear discloses a change in life styles within one short block. A time period between 1812 and 1905 is shown by a series of stores including the Paper Shop, Blacksmith Shop, General Store, Harness Shop, Printing Store, Drug Store, Photo Shop, and finally a nickelodeon showing many interesting silent films. A summer kitchen houses demonstrations of home crafts — living evidence of man's changing environment. A collection of colonial tools and housewares is featured. Many exhibits document interesting events in Franklin County history.

The earth sciences are treated in many exhibits. Astronomy and an understanding of our space environment are presented in changing shows in the Battelle Planetarium. Upon advance notice, shows can be directly geared to specific areas of interest and age level. A new environmental demonstration center features two separate presentations. One, an environmental show, "It's Your Earth," gives a panoramic tour of the world's geography. The three-dimensional aspect of the continuous audio-visual presentation allows the visitor to become a part of the show. The trip takes the student from the depths of the sea to outer space. Spectacular beauty is contrasted with the devastation of pollution. However, the basic theme of the presentation is to show the magnificence of the earth. It is designed to instill an appreciation for our natural resources and for earth's esthetic qualities. An environmental monitoring demonstration, the second function of the center, presents meteorology, climatology, and other aspects of environmental monitoring. Included in the existing demonstration is a teletype hook-up with the National Oceanic Atmospheric Administration. Convection apparatus, thermometer, barometer, wind speed indicator and other types of equipment monitor the elements and show how they influence our weather.

Industry, technology and physical science are represented in the fourth area. Man's industry is a part of his environment, and industry provides the technological tools to create this environment. Introductions to industrial processes and research are given in "Communications," "Paint," "Environmental Controls," "Steel Center," "Aviation," "Glass," "Oil," and the "Coal Mine." These exhibits give insights into the process and the products. The visitor is taken through a simulated coal mine and sees modern as well as historical methods of mining. The Story of Electricity explains electrical power and man's utilization of this power. Research and development are shown in the communications exhibit as well as the working of a complex telephone system. Product development and function are part of environmental controls. Manufacturing methods are shown in glass and oil exhibits. Special lecture demonstrations may be requested to expand the effectiveness of the visual aids. The Story of Energy and the energy crisis is given in the energy laboratory. Man's use of energy is vividly described, and suggestions for future energy sources, including nuclear and thermonuclear sources, are discussed. A presentation concerning the basics of electricity is also available. Finally, the perception and optical illusion demonstration explores perception not only

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of objects but of events, attitudes and ideas. Man's perception is based on prior experience and understanding. This concept increases an understanding of individual attitudes.

Information on scheduling group programs can be obtained by writing or calling COSI. Consultation concerning specific objectives and before and after visit sessions may be requested.

In addition to these facilities and programs, COSI features a wide variety of film programs, special classes and seminars, traveling exhibits, and special educational programs. A newsletter listing all events is sent to members.

Special seminars or classes can be developed to provide for a more in-depth experience in any of the areas. A charge is made to cover costs. Parking is available at minimal charge within two blocks. General admission charge is $.50 for students and $1.00 for adults. The planetarium fee is $.25 for students and $.50 for adults in addition to general admission. Contact: Director of Education, Center of Science and Industry, 280 East Broad Street, Columbus, 43215, phone: (614) 228-6361.

Watching the pendulum at COSI

DAIRY FARMING IN MORROW COUNTY

Location: One half mile east of I-71 and SR 95 interchange near Chesterville.

Because dairy farming in Ohio has been historically significant as a land use and resource management program and continues to be a major agricultural business, and because there is a growing concern for energy use and water quality, this study is recommended for junior and senior high school students. It will focus on one farm management program which is exemplary in many respects. The manager, Gerald E. Robinson, was voted the outstanding Young Farmer in Morrow County in 1973 and runner up in the statewide competition sponsored by the Ohio Jaycees.

The thousand acres of farmland managed by the Robinson family are situated in the glaciated Allegheny Plateau foothills of eastern Morrow County underlain by the sandstones and shales of middle Mississippian time. The soils are in the Alexandria-Cardington-Bennington group, medium acid, deep, moderately well drained and undulating. Productivity is moderately high when erosion is controlled on slopes and drainage is provided on the more level areas. (Ohio Division of Lands and Soils, *Know Ohio's Soil Regions*, 1962). The wooded areas are typically beech maple forest association, little used now for grazing.

Both Gerald and Mary Lou Robinson are natives of eastern Morrow County. In 1966 Gerald elected to discontinue his factory job to go into full time dairy farming. He didn't make the change from factory to farm for the sake of less work or a steadier income. "Farming is neither," he says. "You work more hours and your net profit can be as unpredictable as the weather. But there's something interesting happening every day."

The happenings center largely around the production of milk and providing the feed for the stock. The farmer's present investment in machinery is $140,000 — yet he does not own the land. In addition to the machinery, he and his brother-in-law, who has worked with him ever since he began full time farming, own half the cows and part of the silos. Investing in this way has enabled them to realize a better income than they could by farming their own small farms with poor equipment.

Three major crops planted for feeding the large herd of cattle are corn, alfalfa, and oats, with soy beans as a cash crop.

Since starting the dairy, the Robinsons have made many improvements to handle a growing herd efficiently. They began with 32 cows which averaged 12,000 pounds of milk the first year. In 1973 they are milking 113 cows that are averaging 14,402 pounds per year. With total production over 1.6 million pounds, labor saving devices which use a lot of electricity are necessary. The Robinsons have been on the lines of the Morrow Electric Cooperative from the outset. Electric bills amount to $150 per month, but electricity is computed to be the cheapest labor possible. Electricity operates four silo unloaders, a 1200 gallon bulk milk tank that takes two compressors, six milkers that run four hours a day, and numerous household appliances.

Mr. Robinson is sold on his modern air-tight silos. His purchase of the first one was a big turning point in his dairy business. Before storing feed in the oxygen-free structures he was "just getting along." The cost of the purchased feed was $12,000 a year. After the new installations, with twice as many cows and higher prices, the cost of a year's feed was $6,500. The difference is that the silos preserve more protein and other feed values.

Modern practices included hiring a plane in 1972 to seed rye into fields damaged by alfalfa weevil. The fields were too wet for wheeled equipment. The rye was placed in silos in May when it was high in protein, and helped to make up for feed lost to the weevil. Improvements to the drainage system of tile and grass waterways are made yearly.

Farm management practices on the Robinson acres include pollution control. The Robinsons installed a waste control system, the first in Ohio, which uses a piston pump to move manure 250 feet through a nine-inch vinyl pipe to a 380,000 gallon holding pit. He scrapes manure from free stalls and from around the feeder into a pump hopper in the low part of the concrete area. The pump then pushes the waste through the pipe to an outlet in the bottom of the pit. This pit holds enough to handle 150 cows for six months. Because the manure goes to the bottom a thick crust forms on top which prevents odors and flies. Eventually the manure is spread on the fields. The total cost of the dirt walled pit was $5,900, a saving of $20,000, Robinson estimates, over a concrete pit.

The Robinson program includes double cropping of 40 acres a year. He takes off a first cutting of hay, then plows and plants a short-season corn hybrid. This produces an extra 40 acres of corn not otherwise possible.

In 1972 the Robinsons received the Governor's Award for Community Action due to their volunteer program of conducting tours through their operation. A nearby campground brings many urban and suburban families who have never been on a modern farm. They learn about cow feeding and breeding, how to keep the milk below the state maximum bacteria count, and many other aspects of farm living. The Robinsons are willing to continue this practice for school classes. Contact: Gerald E. Robinson, Route 3, Mt. Gilead, 43338, Phone: (419) 768-2565.

DEAN AND BARRY PAINT COMPANY

Location: 296 Marconi Boulevard, two blocks north of City Hall in downtown Columbus, Franklin County.

Paint is a product of increasing importance in our society. It freshens, beautifies, highlights some objects with color, softens or obscures others. It protects surfaces from weathering. Rapid deterioration of it is an index of environmental situations which could be harmful to the physical health of people in the area. High lead content in paint, now illegal, has been blamed for the illness and even death of small children who chewed painted furniture. Paint, tastefully applied, provides a lift to the human spirit.

No one really knows when man first began to paint, the researchers tell us. Primitive man drew pictures on the walls of his cave or on cliffs beside a stream. Presumably the paint was a paste mixture of natural materials, applied with the fingers, pieces of wood or bone. And the paintings had a story to tell.

From Egyptian art works buried with the dead, there is evidence that paints were used by these people in 5000 to 1000 years B.C. They used natural ores as pigments, burned bones and wood for charcoal. It was the Greeks who brought painting into extensive use. They decorated homes, temples and everyday objects. When Rome conquered Greece in 146 B.C., the conquerors called upon the Greek artists to decorate the new buildings they constructed. Later, in the Dark Ages, painting declined, as did most other great cultural pursuits. But the Renaissance revived decorative taste and skills and progress has steadily continued.

The first paint mill was established in this country around 1700 by an Englishman, Thomas Child, a master painter. He made paint in a rectangular stone about 12 feet long, hollowed out to form a trough. Raw materials were placed in the trough and a second stone, a ball about 20 inches in diameter, was rolled back and forth until the ingredients were mixed. From 75 to 100 gallons of paint could be made at one time.

Mass production and ready-mix paints did not appear until the late 1800's. Research chemists discovered new materials and combinations of materials and the manufacture of paint became a specialized science. Today there are more than 1500 paint manufacturers in the United States employing over 77,000 people.

The Dean and Barry Company has been in business for 82 years. It was originally a wholesale outlet for a number of products but eventually developed into a paint manufacturer and distributor of paint-allied products. A grandson of the original owners serves as the president of the company, which does a $4 million business annually.

Paint may be defined as a material in liquid form which when spread in a thin coat or film on a surface dries to a solid substance. To produce this quality four basic ingredients are combined, as in a recipe. They are:

1. Pigment—the solid coloring material. This may be white, coming from minerals containing zinc, lead or titanium. The materials are processed in several intermediate steps after mining before they can be used as paint pigments. The process of procuring a lead carbonate from the lead ore is an involved and fascinating one worth researching. Zinc oxide is formed by combining oxygen with the zinc metal at high temperatures. Lithopone is an important white pigment formed in the combination of sulphur, zinc and barium sulfate. Titanium dioxide, probably the best white pigment, is composed of titanium, a light, strong metal mined as ilmenite. Titanium is the ninth most common element in the earth's crust; its volume more than equals all the lead, zinc, nickel, copper, tin, gold and silver combined. Titanium dioxide as a paint ingredient, in addition to being abundant, is not poisonous, has a high degree of permanence, is easily mixed with oils, is light in weight and has excellent hiding capacity.

Colored pigments are earth materials, organic or inorganic, natural or synthetic. Iron oxides from ores of hematite magnetite, limonite, siderite and pyrite have been used by man throughout history. Chemical precipitates of these inorganic ores are processed, as well as organic pigments derived from hydrocarbons.

Extender pigments are either naturally occurring deposits or manufactured by chemical reactions. Among the most important are calcium carbonate ("whiting"), barium sulphate, and silicates such as talc, kaolin, mica and gypsum. Extenders are necessary to lend proper consistency, brushability, and sheen, and to decrease the settling of the pigments.

2. Binder—the liquid part that holds or cements the particles together. Binders are both vegetable and marine oils and natural and synthetic resins. Oils come from seeds—flax seeds, soya beans, tung tree, and castor bean—and from fish oil—sardine, herring, and menhaden. Most resins are now made synthetically from chemicals. To be of value binders must dry to a solid film. Oils and resins require many different processes to convert them to drying oils.

3. Volatile matter—a thinner and/or solvent, a substance used to control the consistency of paint by dissolving or diluting the binder so that it can be applied to a surface. Some of these are turpentine, mineral spirits, napthas (from petroleum), napthalene (produced from coal), and alcohol from fermentation of grain.

4. Drier—a chemical compound or element added to paint to make it dry fast. The most important are lead, cobalt and manganese.

The Dean and Barry plant is a typical four-story building. Gravity assists in the movement of materials. The top floor contains an assortment of necessary raw materials for each batch of paint. A stockpile of the white pigments, each of the base colors, and the necessary wetting agents and liquids are in evidence. These are mixed in large vats as a formula card for each batch specifies. Mixing is considered the most important operation, for the better this job is done, the easier it is to grind the paste to a smooth and uniform consistency. The dry pigment and liquid are poured into large vats, open at the top, which have revolving shafts that turn mixing blades.

After the paint has been mixed for the required number of hours, the mixture flows in troughs to the third floor. The paste is funneled into a ball grinding mill which pulverizes the particles and breaks up any lumps left from the mixing operation.

From the grinding mills the large vats of newly ground paste are wheeled to the thinning and tinting department on the same floor. Here the thinners are measured and added, changing the paste to a liquid consistency according to the formula. An expert shades the mixture by adding tinting colors if required. This is a very exacting process requiring skilled people.

Before the paint is canned, a small sample is taken to the control laboratory, a modern well-equipped room with a competent chemist in charge. Here the material is tested for consistency, covering, drying time and color to be sure it meets specifications. When it is approved by the chemist, a sample is coded and retained for reference.

The next step consists of wheeling the vats of mix to a hole in the floor where a spigot is opened and the paint flows through a combination funnel and strainer to a tank on the floor below. Here it is again agitated, then poured through a strainer into filling pipes. Measured quantities flow into cans which are labeled and packed into cases. These are moved by conveyor either to storage or to the shipping department to fill an order.

The Dean and Barry Company has a printing department for creating its own labels. It has 18 classifications of paint and varnish, 920 items. A B-line of items such as sand paper and spray antique kits is also purchased and shipped. The company manufactures a total of 800,000 gallons of paint a year, as much as 3000 per day. It supplies 54 stores, 37 of which it owns, primarily in Ohio.

The company complies with the law which requires that paint shall contain no more than .5% lead. However, its technicians note that yellows and greens are not as clear; the quality is not quite the same. There is a proposal currently to set this figure at .6%. A careful examination of illnesses attributed to lead suggests that all factors may not have been given adequate consideration. Research is the key to improvement in methods and materials. Contact: Dean and Barry Paint Company, 296 Marconi Blvd., Columbus, Ohio 43215, phone: (614) 224-3131.

GERMAN VILLAGE

Location: just south of I-70, one block east of High Street, between Pearl Alley and Lathrup Street, Columbus.

This restoration project is a slice of old Germany. The present quaint authentic atmosphere of German Village demonstrates the meticulous care taken to recapture the past. It is an outstanding example of how intense desires of private citizens to improve and restore an environment can become a beautiful reality. German Village is a highly successful attempt to preserve and restore a community, retaining a charm and unique Old World atmosphere almost unmatched in America.

Throughout our nation's history, Italians, Poles, and Germans alike fled to this country in hopes of finding freedom to maintain their strong cultural heritage in custom, language, and love of home, and to achieve socio-economic security. They settled in enclaves throughout the country. Germans were lured to Columbus by rich soil, forested lands, and the prestige of the state capital. In the early 1800's they began building their community on the south side of Columbus. These first homes, with their gas lanterns, wooden shutters, and geraniums growing in the window boxes, clearly showed a sense of balance between function and beauty.

With the advent of World Wars I and II patriotism in America soared, accompanied by intense distrust of German-Americans. The German descendants across the nation, including those in Columbus, found themselves living in an ostensibly free country, yet confronted by its "patriots" who felt justice in maliciously attacking German culture. During World War I, Schiller Park in German Village was the site of massive burning of German books and paintings which the villagers could only watch with sorrow. Many villagers felt they had to anglicize their names to protect their families; thus Schmidt became Smith, or Muller became Miller.

The great depression brought economic disaster to the area. Residents left, and the original community fell into shoddy disrepair.

By 1959, the area was ripe for urban renewal. In 1960, villagers decided to restore their homes to their original character rather than allow the bulldozers of the urban renewal process to obliterate the last vestiges of a proud cultural enclave. The German Village Society was then founded to stimulate this long and uncertain process of renovating the homes of the residents. The society, a non-profit organization, has since provided enough momentum to influence the restoration of 500 homes in the Village and achieve national acclaim for these efforts.

Many Americans do not feel a very obvious physical sense of identity with their community. German Villagers do because of the consistent yet curious architecture, the landscaping, and the feeling of warmth which pervades the streets and shops. The bright lively gardens trimmed with red brick and the stained glass windows are constant reminders to them of where they are.

On a stroll down the red brick sidewalks of Beck Street, visitors immediately notice the tall single-family homes, and the story-and-a-half styles so common to the Village. They are likely to be newly sandblasted and display painted door trim and hand carved stone steps. The lots are very narrow, but the backyards are filled with flowers and vegetable gardens.

Much of the beauty of the Village is inside the homes and stores. The typical German Village shop offers its shoppers no carts or mile-long shelves with products. It does, however, offer the uncommon personal touch of its owners, who gladly guide shoppers through the jungle of ferns and geraniums, wine racks, paintings, or ceramics. A wide variety of craft and souvenir shops are scattered throughout the Village selling everything from candles to restored, and not-so-restored, antiques. At least five restaurants serve the famous German sausage, kraut, and potato salad. In the evenings, villagers and their neighbors gather here to laugh and sing along to the simple music of an upright piano or an accordian.

In total, the Village is an environment for people to whom a sense of community and history is all important.

The Village offers a tremendous learning opportunity to discover alternatives to the design of today's cities. There is a conspicuous absence of strip development even along the main thoroughfare, Third Street. Schiller Park offers a variety of recreational opportunities, including carp fishing, tennis, sewing lessons, or just plain relaxation on the grass. The fossil-laden Ohio limestone steps can even offer a lesson in geology, while the 75-year-old maples and elms gracefully speak of the need for green in a community. The most important lesson, however, is that citizen commitment to improving a community environment can create an exciting, beautiful place to live.

Tours can be arranged with the Society, preferably on Tuesday through Friday. Transportation and meals should be arranged directly with the transit companies and restaurants. Student rate for the tour is $20 for less than 20 people, or $1 per person for 20 or more. Contact: The German Village Society, 624 South Third Street, Columbus, Ohio 43206, (614) 221-8888.

MAKING PAPER AT THE MEAD CORPORATION

Location: In the southeast section of Chillicothe.

The paper on which this story is printed, as well as the great mass of material produced to carry messages from man to man, is the product of a tremendous industry. Its contributions to modern society, to education, and to communication are so great that no one denies its importance. The industry requires wood products; it uses vast amounts of mineral resources; and the processing creates problems in air and water quality. A trip through a paper making plant provides a new appreciation and understanding of the process and the product.

To make paper, it is necessary to prepare a pulp from fibers, float the fibers in water, scoop up a thin layer on a flat screen and squeeze it dry. That's what T'sai Lun did when he created the first piece of paper in China centuries ago. Essentially this is the way paper is still made, but the modern machines and techniques used today, which speed up the process many times over, fit together like a Chinese puzzle.

Paper as we know it was first produced in China more than two thousand years ago. The process remained a secret for several hundred years, but during the eighth century the secret was discovered by Muslims who later invaded and swept across Europe, introducing the process there. Early parchment was eventually replaced by paper in many cities in Europe. England is reported to have started manufacturing paper in large quantities during the sixteenth century and supplied all of the needs of its colonies for many years. As the demand in America grew, two enterprising gentlemen in Philadelphia started a paper mill in 1690. Paper was generally made by hand until the invention in England of a machine that produced it on an endless wire screen. This was called the Fourdrinier machine and was patented in 1799. The first machine to appear in America was a cylinder type, made in England and installed near Philadelphia in 1817.

Mulberry fiber was the magic ingredient in the early Chinese paper, but this remained a secret for centuries, and rags were the basic fiber-producing material. It took an observant Frenchman to notice fibers in a wasp nest and to discover that the fiber was wood. Abundant wood supplies were available, and the cost of making paper became less. New machines increased volume and further reduced costs, so that paper came into its own as one of the world's most useful and versatile manufactured products.

Mead Paper Corporation began in Chillicothe in 1846, when a small group of craftsmen operated a one-machine mill in the middle of an oak forest. The growth was slow at first, but the pace quickened until today Mead is one of the giants in the paper making world. In 127 years a company can gain much experience and amass quantities of research materials. Mead Corporation, its great acres of woodlands, and its subsidiary companies stretch across the continent and into Canada.

The Chillicothe mills, which now encompasses the old Chillicothe Paper Mill, as well as the gradually developing complex known far and wide as "the Mead," has 50 acres under roof and along Paint Creek. Over 3000 men and women and 15 paper machines produce 1000 tons of paper a day. There are 4000 items emanating from this white paper-making center, like bond, mimeo, greeting card paper, coated papers that require no carbon for seven copies, and Mark I, an especially heavy, glossy paper with a mirror-like surface.

It all begins in the woodyard. Hardwoods of Ohio, Kentucky and West Virginia are reduced to chips from which the cellulose fibers must be released, bleached, and blended in a web, or sheet of paper. It takes about three tons of wood chips to make a ton of paper. Each day great quantities of oak, maple, beech, poplar, gum and hickory come into the yard. The Mead Corporation owns more than 140,000 acres of timberland in Ohio. Repeated crops of trees are grown.

Wood arrives in truck loads of five-foot logs, in the form of chips on railcars and trucks, and in long logs. The logs are lifted by a giant loader with enormous jaws to the Starr deck where an operator in a tower resembling an airport facility manipulates the logs through a noisy debarker which looks like a pencil sharpener. The debarked logs go then to a horizontal chipper, the chips moving to the storage pile. A bark mulch from this process is sold as a byproduct to nurseries or other buyers.

From the storage pile, chips are conveyed to the digester building for the first step of the actual papermaking process. The eight digesters are actually enormous pressure cookers where the wood fibers are cooked in a mixture of soda ash and lime for three hours and then blown into a tank and on to the pulp washers. The iodine-colored liquor from this process is not dumped into a sewer. After evaporation to concentrate, it is pumped into a recovery furnace where it goes through a two-stage odor reduction process of oxidation. This reduces it to a semi-solid state which can be used as a fuel.

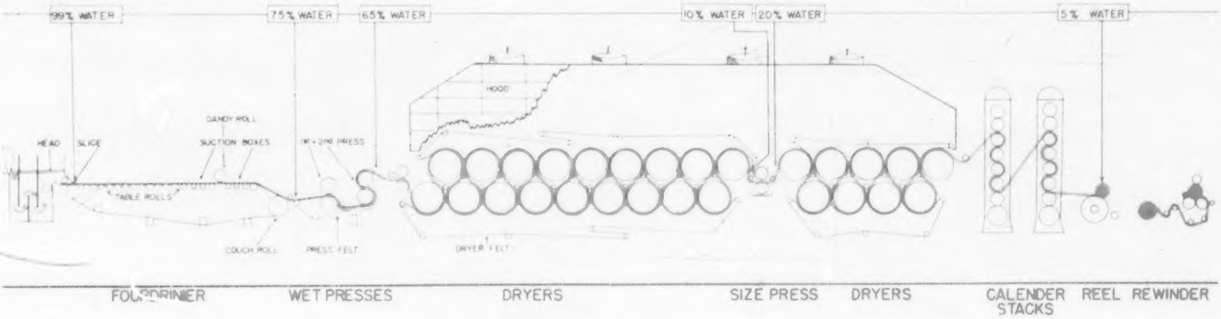
The oxycat, a gas-fired unit in the pulping system, is used to destroy the cooking odors which originate in the digesters.

The brown stock of wood fibers, still discolored by lignin and other impurities in the wood, is fed over large washers to remove the chemicals. It is then treated in the bleach plant, a highly sophisticated process controlled by instruments which give data on consistency, flow, brightness and other qualities.

This is one of the most up-to-date computerized systems in the paper industry.

After the four stages of bleaching, the white fibers are pumped to the paper machines. At the wet end of a huge paper making machine the fibers are fed onto a wire called the Fourdrinier. This is where the miracle of paper making takes place. The 99% water stock flows onto the screen which travels swiftly over a series of steel rollers. The water drains away and leaves a web of wet fibers. These are picked up by a series of felts and carried through presses to remove more water. The sheet then passes through a series of large revolving steam-heated drums. At the dry end the paper moisture is carefully controlled so that the final product now contains five percent moisture, this much required to make paper lie flat.

THE FOURDRINIER PAPER MACHINE



The paper is treated with a coating of cornstarch, clay or adhesives to provide a smoothness of surface for better printing detail.

There are 15 such machines producing various kinds and sizes of paper rolls. The finished paper is cut, some retained in rolls, some cut in sheet form, wrapped, packed in cartons and stored or shipped. It is difficult to imagine the vast quantities of white and colored stock in various stages of processing which come from the giant machines.

In a quality control department, rigorous tests are made to be sure the paper meets the requirements. Equipment for testing includes offset and letterpress presses, a proof press, duplicator and mimeograph.

Waste paper is collected throughout the plant and returned for reprocessing. Recycled paper from waste material is not made at this plant.

A lime kiln converts once used lime mud into usable lime to make the caustic solution for cooking the wood chips in the digester. More than 140 tons of lime are needed per day, which makes recycling an economic process. The used lime mud is fed into a slowly revolving kiln, fired by natural gas. Once burned in the kiln, it is quick lime and ready for use again. The recovery is 90%.

The Mead's primary waste treatment plant is designed to process 35 million gallons of effluent daily. Solid materials from the paper making process are removed from the water by centrifuges and trucked to landfill areas. The clarified effluent is pumped to a ten acre lagoon where retention time, aeration and biological processes prepare the water for its trip down Paint Creek which is adjacent to the lagoon. Seventeen aerators keep the water in constant motion. Expenditures for this type of installation during the past 18 years approach $7 million.

It takes 40 million gallons of water to dissolve the chemicals, carry pulp, and to float the fibers of cellulose into position on the paper machines. More than a thousand tons of coal are burned in boiler houses to make 1,300,000 pounds of steam an hour. Steam heats the plant, cooks the pulp and dries the paper.

Nine steam-driven turbines are capable of generating 1,200,000 kilowatts of electricity a day, enough to serve a city of 100,000 people.

A 475-foot smokestack towering over the Mead plant is a Chillicothe landmark. The smokestack diffusion is reportedly quite effective in reducing the paper making smell.

Tours of the plant may be arranged for students 14 years of age or older. Contact: Public Relations Department, The Mead Corporation, Chillicothe 45601, phone: (614) 772-3111.

MEAD EXPERIMENTAL FOREST

Location: On Bear Creek Road near Wakefield in Scioto County.

The purpose of this study is to provide a place and information leading to an understanding of wood as a renewable resource, a timber crop and one of the largest businesses in the nation. "This gigantic enterprise includes over 500 million acres of commercial U.S. forest and employs more than one and a half million people, furnishes an annual payroll of seven and a half billion dollars and contributes more than 30 billion dollars annually to the gross national product." (William F. Cowen, Jr., Extension Forester, *Forest Resources*, 1972.) It is easy to see that trees are one of the most important environmental assets from an economic viewpoint. About 50 percent of the annual timber harvest goes directly into home building. In addition, trees are recognized as air conditioners and noise abaters. Wood and wood products are continuously recycled; they are biodegradable and require energy only from the sun.

Ohio's forest wealth is concentrated in the hill country of southern Ohio where forests occupy 50 percent of the land. In the past, agriculture, coal mining and iron ore extraction and manufacturing furnished the economic base for the area. Each has declined in importance as Ohio's history has unfolded; unemployment has increased, population and general levels of living have decreased. High quality trees, which found a ready market, are scarce; the hills are covered with low value trees. But the land, once completely forested, still retains its capacity to grow valuable timber.

The Mead Corporation, a widespread white paper making industry with its original plant at Chillicothe, uses tremendous quantities of wood for paper making. Research on desirable species of trees and forest management procedures are carried on to improve and maximize wood production. The corporation acquired 700 acres of land for an experimental forest in Scioto County after it had served as farmland, cattle ranch, sheep pasture and peach orchard. The property was dedicated as a field laboratory for timber management research and demonstration purposes. United States Department of Agriculture Forest Service research studies have been carried on since 1962 under a 25-year cooperative agreement with the Mead Corporation. Logging necessary for the studies is done by commercial timber contractors.

The research area lies in the unglaciated part of Ohio underlain by sandstone and shale formations of the Mississippian period. The soils are residual, having developed from the weathering of the rock in place. They are variable with moderately deep and well drained soils in coves and on lower slopes. Poorly drained and thin soils are found on the ridge tops.

Few stands of forest bear much resemblance to the original vegetation, which was classified as mixed mesophytic. Trees on the more gentle slopes and along ridge tops are mostly black, scarlet, and red chestnut and white oaks. They are essentially even-aged, resulting from reversion to timber of land cleared for farm or range but later abandoned. The coves, where stands are less uniform, contain tulip tree, white ash and occasional walnut and black cherry in addition to the oaks. Having developed without management, many of the trees are of poor quality for most wood products.

Deer, grouse, wild turkeys and squirrels are the major game species found in the forest. Birds and small animals are abundant.

The topography of the maturely dissected Allegheny Plateau region in which the property is included is varied; the slopes are moderately steep to steep, and the local relief is about 350 feet. Mean monthly temperatures range from 15 to 20 degrees in January and 80 to 90 degrees in July. There are about 170 frost-free days each year and precipitation averages about 40 inches.

The research program conducted on the site consists of three active studies primarily to discover how younger hardwood trees can best be managed for pulp wood, sawtimber and integrated products.

The pulp wood cutting methods study is a comparison of different methods in even-aged stands 60 to 80 years old on both good and less favorable sites. Thirty-four plots, one and eight tenths acres in size, are the basic units for study. Cutting ranges from heavy to none. The true clearcut removes all trees larger than two inches in diameter. Merchantable trees are harvested and all others are killed or left on the ground to eliminate trees that would be unusable for wood products. Seasonal cuts are made and compared. So far reproduction has been excellent regardless of season.

The first partial cut, a commercial clearcut, was made on one plot of the good site and one plot of the medium. A light stand of trees, mostly hickory and sassafras under five inches in diameter, remained.

The second partial cut was based on size-class management in order to compare a shelterwood cut with a diameter limit cut. The shelterwood cut removed about one half the total cubic foot volume by cutting the understory—trees four to eight inches in diameter. This left the larger trees to grow. The diameter limit cut removed the canopy trees which were more than 11 inches in diameter. Smaller trees were left to grow. These plots are being compared to see which type, shelterwood or diameter cut, yields the best growth.

The lightest of the three partial cuts was based on species management. The plots were reduced to about 60 percent stocking by a combined harvest

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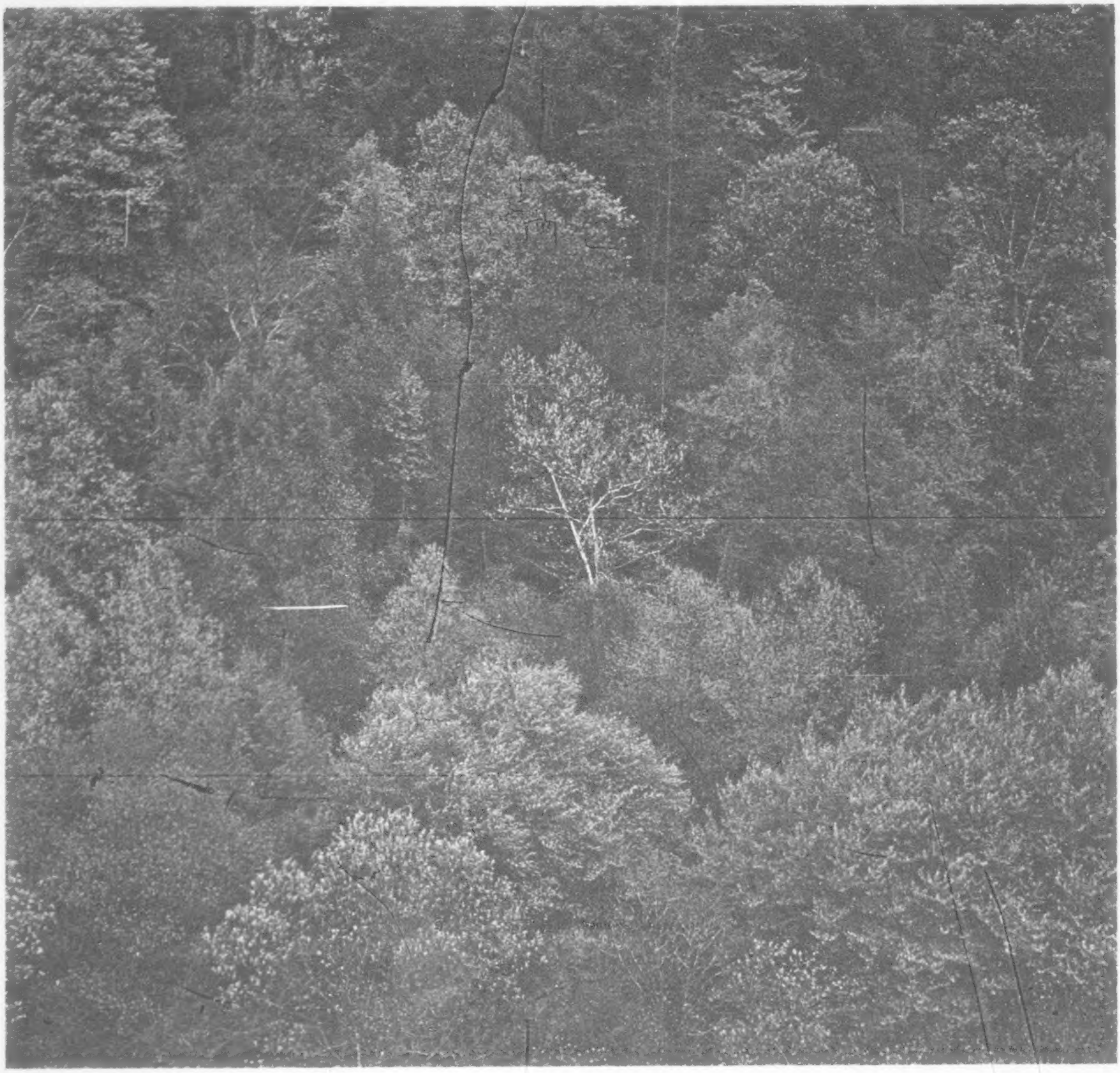
and management cut. Managed plots of various species of oak, tulip and oak-hickory are compared. Unmanaged parts were left as check parts.

A second study of clearcutting was made to see whether clearcutting of large areas would produce the same good results as in small ones. Reproduction in these 30- to 40-acre plots has proven to be excellent. No report is made regarding erosion problems.

A third study is one to determine the growth and yield of mixed-oak pole stands after various degrees of thinning. This oak density study consists of 16 plots, located in 60-year-old mixed oak stands growing on medium quality sites.

The studies on demonstration areas show the advantages of forest management. Among other things they indicate that clearcutting promotes the largest amount of reproduction of the valuable species and regenerates mature stands. A field trip to the area may uncover some trade-offs which might be considered. Signs are located at intervals explaining the program so that interested individuals may understand what they are observing.

A tour is recommended for high school groups only. Contact: Herbert L. Morgan, Mead Corporation, Chillicothe 45601, phone: (614) 772-3422.



An Ohio woodland

SOUTHERLY WASTE WATER TREATMENT PLANT

Location: On US 23 one mile south of Shadeville.

This extensive, modern, isolated, waste treatment facility, one of two for the city of Columbus, looks very much like a college campus. Distributed over thirty acres on the east side of the Scioto River in its broad flood plain, it offers an opportunity for school classes to grasp the magnitude of the waste situation as well the processes necessary to maintain water and air quality.

The concern for waste treatment began in Columbus in 1905 when a comprehensive study was made by George S. Johnson on sewage purification. This resulted in a contact filter plant. In 1938 the huge Jackson Pike plant, just south of Frank Road, was completed with the anticipation that it would fulfill the city's requirements for many years to come. But in 1963 it became apparent that greater facilities were needed, and the purchase of farm land and construction for the Southerly plant began.

The facility now knows no completion date. Most of the present operation was functioning in 1967, giving a nominal capacity of 60 million gallons a day. Construction is almost completed on an expansion program which will increase the plant's capability by another 60 million gallons per day. The Jackson Pike plant serves the western side of Columbus with a processing capacity of 83 million gallons per day; the Southerly meets the need for all those east of High Street all the way to Westerville. The new plans call for an interconnecting line between two plants for excess from the older installation.

The persistent increase in waste water treatment is a reflection of the comparable expansion in the city's water reservoirs. First Griggs Dam on the Scioto was constructed. This was followed by a larger reservoir, the O'Shaughnessy. In 1955, Hoover Reservoir on Big Walnut was completed, and now Alum Creek dam is ready for additional surface storage. Officials predict that even this reservoir will not long suffice to meet the expanded needs of Columbus.

The tour of the plant begins with a visual diagrammatic presentation as modern and attractive as the administration building in which it is located. A large panelboard occupying one end of a room, controlled by electric push buttons, shows the complete operation, step by step, colored lights pointing out each part as it is described. In this manner a basic understanding is established before the trip through the many buildings.

The waste water and sewage treatment process has two component parts. They are the separation and treatment of suspended solids and the treatment of liquid waste water. The waste water enters the plant through a nine foot pipe. The first phase in the treatment process is to screen out any debris that would damage the machinery in the plant. The waste water is then pumped through a series of very large tanks where it is alternately aerated and allowed to settle. In addition, aerobic (oxygen-loving) bacteria in a medium called activated sludge are used as an important part of the treatment process. The final stage in the water treatment process is the use of chlorine to disinfect the water before it is discharged into the Scioto River.

The settled solids are treated by the use of anaerobic bacteria. The sludge is then filtered, incinerated, and the ash deposited in two large ash lagoons. A byproduct of the digesting process by the anaerobic bacteria is methane or sewer gas which is used as a fuel for the incinerator — a very good example of recycling.

BOD (biochemical oxygen demand) tests of a composite sample of the water going into the Scioto River are made every other day at the plant laboratory. Ohio Environmental Protection Agency has begun a stream surveillance program which will evaluate effects on the river.

The activated sludge treatment at this facility is commonly known as secondary treatment. Plans for a tertiary step, which will be the use of alum for phosphate removal, are near completion. Further steps are anticipated.

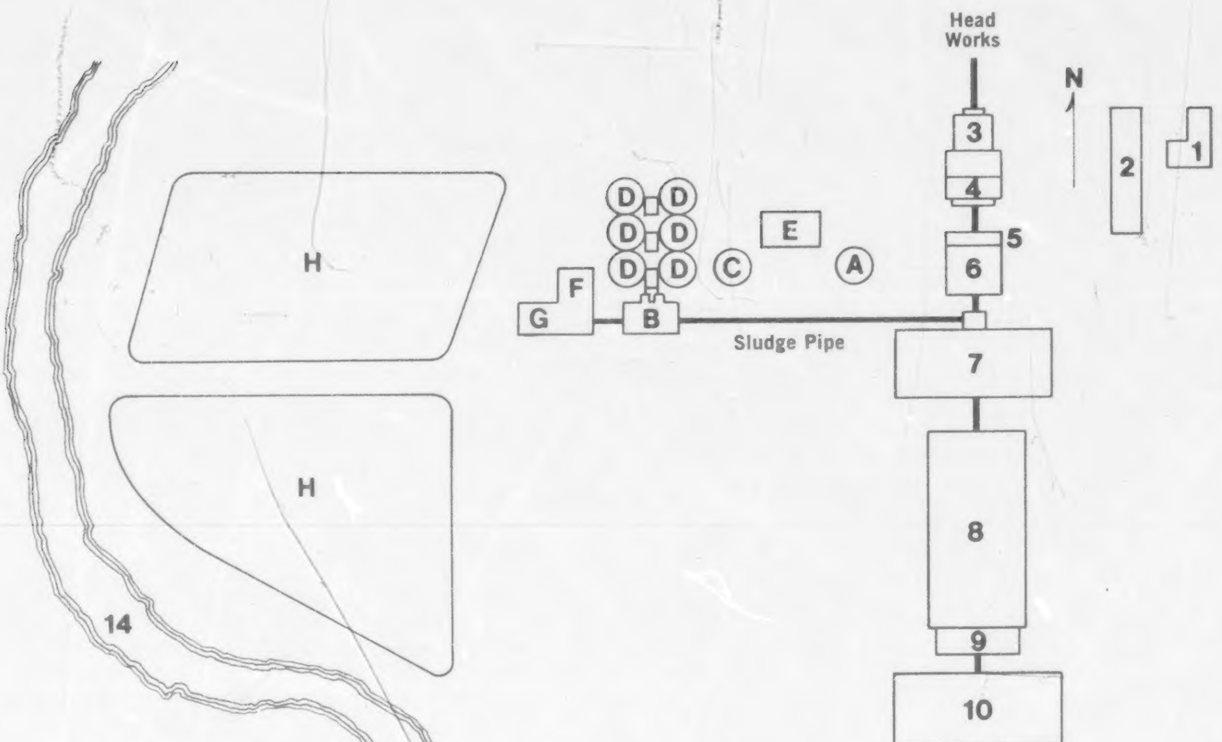
The services performed by the Southerly plant are financed by revenue based on water consumption. Capital improvements were made by bond issues and federal EPA monies. A further study of government financing by high school social studies classes is recommended.

Guided field trips through the plant provide a significant educational experience. They may be arranged on week days with seven days prior notice. The maximum number to be accommodated varies with the age, recommended to be fifth grade level or above. Contact: Columbus Southerly Waste Water Treatment Plant, 6977 South High Street, Box 96 C, Route 1, Lockbourne, Ohio 43137, phone: (614) 491-4413.

SOUTHERLY WASTE WATER TREATMENT PLANT
Columbus, Ohio

A. Water Tank
B. Sludge Concentrator Building
C. Sludge Gas Accumulator
D. Sludge Digester Tanks
E. Sludge Control Building
F. Sludge Filter & Water Removal
G. Incinerator
H. Dry Ash Beds

1. Administration Building
2. Service Building
3. Screening & Grit Removal
4. Pumping
5. Control Building
6. Preaeration Building
7. Primary Settling Tanks
8. Aeration Tanks
9. Aeration Control Building
10. Final Settling Tanks
11. Chlorine Building & Effluent Pump
12. Chlorination Tanks
13. Effluent Outlet to River
14. Scioto River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ADDITIONAL SCIOTO-HOCKING RIVER WATERSHED SITES

Adena State Memorial, Ross County, located three miles north off SR 104 at the west end of Allen Avenue. Contact: The Ohio Historical Society, Columbus 43211, phone: (614) 469-4663.

Restoration of a farm complex in addition to the delightful Thomas Worthington Mansion and nature trails make a field trip to this site valuable for reinforcing history lessons of Ohio and natural history as well.

American Aggregates Corporation, Franklin County, Lockbourne Plant on Lockbourne Road, contact: 399 Frank Road, Columbus 43207, phone: (614) 444-1125.

Educational tours of the operation by bus follow an indoor orientation by the plant manager. The stratified glacial outwash, the excavation, sorting, and floating processes are observed. Reclamation procedures and an opportunity to pick up glacial rocks will be included. Trips may be arranged for junior and senior high school students.

American Aggregates Quarry, Madison County, on Big Darby Creek, Georgesville, Plain City Road. Contact: Manager, Darby Creek Operation, American Aggregates Corporation, 399 Frank Road, Columbus 43207, phone: (614) 444-1125.

In this operation the Silurian bedrock (dolomite) is mined and crushed for aggregate. The depth of excavation will reach 160 feet, which will provide a lake for recreation. Tours, arranged in advance, are conducted for junior and senior high school classes.

Belleville Locks and Dam, Ohio River, Meigs County, on SR 124 at Reedsville, contact: Corps of Engineers, Huntington District, Huntington, W. Va. or P.O. Box 118, Reedsville 45772.

A non-navigable, high lift gated dam with two parallel locks. Paved parking areas, rest rooms and picnic units at site. Permian rocks are exposed on the 186-acre site.

Camp Lazarus, Delaware County, on US 23, 1 mile south of Delaware, contact: Central Ohio Council, Boy Scouts of America, 1428 East Broad Street, Columbus 43215, phone: (614) 253-5513.

Water studies comparing lake and stream, geologic studies of the Ohio shale with its concretions, and the erosion processes, which include overuse, are good programs at this site.

Central Soya, Marion County, 751 East Farming Street, in northeast part of Marion, contact: Chief Chemist, Central Soya Mills, Inc., phone: (614) 383-1181.

Students with a special interest in agribusiness or applied chemistry may arrange for a tour of this feed mill which produces quantities of stock feed. A quality control laboratory, bacteriologic studies, and various measuring procedures give valuable learning experiences.

Columbus Gallery of Fine Arts, Franklin County, location: 480 East Broad Street, contact: Education Department, Columbus Gallery of Fine Arts, Columbus 43215, phone: (614) 221-6801.

The interpretation of man's feeling and thinking about his environment is expressed in the permanent and temporary exhibits upon display here. A representative of the education department will work with teachers to reinforce classroom units.

Community Camp, Vinton County, on SR 328, 3 miles south of New Plymouth, contact: Director, Community Camp, 137 East State Street, Columbus 43215, phone: (614) 228-5696.

Ravines, flood plains, lakes, marsh and rocky hillsides provide a variety of environments for native animals and out-door oriented city young people. Day field trips with reclamation of strip mine land and resource management emphases may be arranged.

Empire Detroit Steel Corporation, Scioto County, located in New Boston, contact: Manager of Communications, P.O. 371, New Boston 45662, phone: (614) 456-2111.

Field trips to this plant may be arranged for high school and vocational school. Flat roll, hot and cold steel is manufactured. Resource management, air and water quality, and energy are related to the steel industry.

Bob Evans Farms, Gallia County, on US 35, one-half mile east of Rio Grande, contact: Manager, Bob Evans Farms, Box 154, Rio Grande 45624, phone: (614) 245-5324.

A farm museum, wildlife barn, windmill, Charolais cattle, Spanish mustangs and nature trails are program possibilities at this home of Bob Evans Sausage.

Franklin Park and Conservatory, Franklin County, at Franklin Park off East Broad Street, Columbus, contact: Superintendent, Division of Parks and Forestry, City Building, Columbus 43215, phone: (614) 461-7342.

The park and its conservatory are among the oldest landmarks in Ohio. The park provides an opportunity to study a wide variety of trees. The conservatory grows exotic plants from all over the world.

Gallia County Rural Water System, Gallia County, Addison Township, contact: Supervisor, Gallia County Rural Water System, Gallipolis 45631, phone: (614) 446-9221, or District Superintendent FHA, Gallipolis 45631, phone: (614) 446-0565.

Three wells located 100 feet apart and 100 feet from the Ohio River supply the water association members with good quality water. A study could involve pipe laying techniques, flood plain problems, uses and abuses of water.

Gallipolis City Square, Gallia County, (no contact required).

A monument in the city square shows the high water marks of several serious floods of the past. Minor flood plain management is shown by the picnic area constructed along the river's edge. Across the river on SR 62 flood walls may be observed at Point Pleasant, W. Va.

Hocking Valley Scenic Railway, Athens County, terminal is located at the junction of US 33 and SR 691 one mile south of Nelsonville. Write: Hocking Valley Scenic Railway Association, Inc., 2366 Shrewsbury Road, Columbus 43221.

A steam locomotive of 1916 vintage with two steel coaches conveys passengers over a section of track between Nelsonville and New Straitsville, providing an exciting experience.

Huntington Galleries, off I-64 near Huntington, contact: Education Director, Huntington Galleries, Park Hills, West Va. 25701, phone: (304) 522-7373.

Special programs in art and culture as they relate to man's activities, as well as delightful nature trails, offer a varied experience here for nearby Ohio schools.

Jeffrey Mansion, Franklin County, at 165 North Parkview in Bexley, contact: Recreational Director, Jeffrey Mansion, 165 North Parkview, Columbus 43209, phone: (614) 258-5755.

The 36-acre Commonwealth Park, which is adjacent to the Jeffrey Mansion, and a small acreage of natural area on the north are good places for a quiet nature study trip. The small natural area lends itself well to a variety of plot studies—soil, plant life and animal life.

Kincaid Fish Farm, Pike County, located on SR 124 east of Sinking Springs, contact: Manager, Kincaid Fish Farm, Latham 45646, phone: (614) 493-5063.

An early migrant settled near this spring in 1797 where the water flows from the porous magma dolomite at the rate of 1900 gallons per minute. In addition to an outstanding geologic phenomenon, the farm hatches bass and muskellunge.

Lancaster Waterworks, Fairfield County, located on west side of Memorial Drive at Wheeling Avenue, contact: Superintendent, Lancaster Water Works, 225 North Memorial Drive, Lancaster 43130, phone: (614) 653-5512.

This plant processes five million gallons of water daily for the City of Lancaster by the zeolite and salt processing method. Classes from fifth grade and up may arrange for a conducted tour

Lockville Canal Locks, Fairfield County, on Lockville Road, off US 33 south of Canal Winchester, contact: Fairfield County Commissioners, Courthouse, Lancaster 43130, phone: (614) 653-1921.

One mile of the old canal containing seven locks and a restored covered bridge spanning the canal may be observed at a small community park.

Logan Clay Products, Hocking County, at 201 East Bowen Street in Logan, contact: Administrative Vice President, Logan Clay Products, Logan 43138, phone: (614) 385-2184.

A conducted tour of the manufacture of ceramic pipe from local clay formations may be arranged for junior and senior high school students. Resource management for necessary products makes this an interesting study for earth science, physics, chemistry and social studies classes. It is one of Ohio's early industries.

Marble Cliff Quarries, Franklin County, entrance south on Trabue Road west of the Scioto River Bridge, contact: Manager, Trabue Road Quarry, Marble Cliff Quarries, Inc., Columbus 43204, phone: (614) 488-3030.

The Columbus limestone quarried is widely distributed for use as flux, in buildings, ballast, roads, concrete, lime and fertilizer. A field trip to the site shows resource management and gives a look at air and water quality.

Mercer Property, Hocking County, on old Buckeye Road south of Sugar Grove, contact: Elbert W. Mercer, Box 200A, Route 1, Sugar Grove 43155, phone: (614) 746-8885.

A forest of oak, hickory, beech, hemlock and tulip with very large individual trees, a clean stream, a marsh, rich understory cover, and Black Hand sandstone outcrops provide a variety of undisturbed habitats for study. Arrangements must be made with the owner for sincerely interested students to visit.

Model Environmental Education Study Center, Hocking County, west of Snake Ridge Fire Tower in southeast Hocking County, contact: Ron Isaac, Geography Department, Ohio University, Athens 45701, phone: (614) 594-7119.

Six hundred acres in Wayne National Forest are on research lease to Ohio University. Four distinct community types may be studied for contrast: abandoned strip mine, old field succession, secondary growth in old field succession, and climax beech hickory forest. University personnel will help teachers explore the area and set up plot studies.

Morse Road Water Treatment Plant, Franklin County, just east of the intersection of Morse Road and I-270, contact: Laboratory Office, Columbus Morse Road Water Treatment Plant, 4250 Morse Road, Gahanna 43230, phone: (614) 471-4252.

A bird's eye view of the complex of basins and sludge lagoons, observation of screens that protect the plant machinery, the control room and the chemical feeder mechanisms which give soft and odorless water to the City of Columbus are included in a tour of this plant.

The Ohio Historical Center, Franklin County, located off I-71 north of Columbus, 17th Avenue exit, contact: Ohio Historical Center, Columbus 43211, phone: (614) 469-4663.

A study of the exhibits on natural history, prehistoric man and comprehensive historical displays are valuable learning experiences. An early Ohio village is being developed.

Olentangy River Study, Delaware and Franklin Counties, Delaware City Park, Worthington Outdoor Education Center, Whetstone (City of Columbus) Park, contact: Director, Worthington Outdoor Education Center, 885 Evening Street, Worthington, Ohio 43085, phone: (614) 888-0357, or Institute for Environmental Education, 8911 Euclid Avenue, Cleveland, Ohio 44106, phone: (216) 231-5010.

High school students are invited to participate in an introductory study of the chemistry of a major central Ohio river. Coordination for comparing studies will make them more significant and can be arranged by contact person. The study may eventually compare to the Cuyahoga River Study being conducted by teacher-student teams in that area.

Overlook Hills Farm, Pike County, on Potts Hill Road, four miles south of Bainbridge, contact: Manager, Overlook Hills Farm, Bainbridge, Ohio 45612, phone: (614) 634-2863.

This country estate is a certified tree farm, a conservation cropland and a vacation farm, rich in history and Indian lore. Forest management may be studied, along with other management practices.

Picway Power Generating Station, Pickaway County, located on US 23 just beyond Franklin County Line, contact: Supervisor of Educational Activities, Columbus and Southern Ohio Electric Company, 215 North Front Street, Columbus, Ohio 43215, phone: (614) 228-6411 Ext. 366.

This plant has produced electricity from coal for many years. Although it has mechanical instead of electrostatic precipitators, students can gain an understanding of the process and the problems.

Perkins Observatory, Delaware County, on US 23 south of Delaware, contact: Secretary or Caretaker, P.O. Box 449, Delaware, Ohio 43015, phone: (614) 363-1257.

An unusual plantation of trees, representive species from many parts of the world, and a special rock garden make a choice daytime study area for serious high school students. Monthly guest nights for studying astronomy may be attended in small groups. Prior arrangements must be made.

Poston Electric Generating Plant, Athens County, between Nelsonville and Athens off US 33, contact: Supervisor of Educational Activities, Columbus and Southern Ohio Electric Company, 215 North Front Street, Columbus, Ohio 43215, phone: (614) 228-6411 Ext. 366.

One of the older generating stations, this plant offers an opportunity to observe the complete fossil fuel generating process.

William Powell Educational Laboratory of Buckeye Valley High School, Delaware County, located east of Radnor on Radnor Road, contact: Director, William Powell Educational Laboratory, Buckeye Valley High School, 901 Coover Road, Delaware, Ohio 43015, phone: (614) 363-1349.

A 300-acre farm has been dedicated for outdoor education of four types: 220 acres are used by students to practice actual farming; agriculture demonstration plots; 35 acres of woodland where forest management is practiced; and abundant habitats for natural environment study. School classes are invited to make an exploratory field trip under trained student leadership and to extend study of plots, and other projects. Prior arrangements must be made.

Racine Locks and Dam, Meigs County, Ohio River near Letart Falls, contact: Lockmaster, P.O. Box 38, Letart, West Virginia 25253, phone: (614) 247-2875.

A non-navigable, high-lift, gated dam with two parallel locks, vertical lift emergency gates which have been in operation since 1967. Site has facilities but only a few scattered trees, plenty of Permian rocks. Resource management of water may be evaluated.

Ranco Corporation, Delaware County, 555 London Road, Delaware, Ohio 43015, contact: Personnel Director, phone: (614) 363-1225.

Teachers may arrange for junior or senior high school class trips to see the manufacture of thermostatic controls for automatic ranges, air conditioners, furnaces, automobiles and numerous other familiar appliances from the raw material to the finished product.

Rolling Acres Vacation Farm, Hocking County, west of SR 374 between Ash Cave and Cedar Falls, contact: Don L. Davis, Route 1, Logan, Ohio 43138, phone: (614) 385-5582.

Recreational facilities have been added to a beef cattle and tree farm for observation by students of any age.

Shady Meadow Amish Farm, Madison County, contact: Mr. and Mrs. Jacob Stolzfus, Route 2, Plain City, Ohio 43064.

A neat Amish farm gives city children a chance to meet farm animals, see a windmill, milkhouse, grain bins, fruit cellar and other aspects of farm life. A small fee is charged.

Shallenbarger Nature Preserve, Fairfield County, (Allen's Knob), located three miles west of Lancaster on US 22 at Beck's Knob Road, contact: Fairfield County Commissioners, Courthouse, Lancaster, Ohio 43130, phone: (614) 653-1921.

This delightful undeveloped area features outstanding exposures of Black Hand Sandstone and climax oak forest. It has been deeded to the State Department of Natural Resources as a nature preserve. Classes may arrange to use the area for natural environment studies.

Snortin' Ridge, on the Fairfield-Hocking County Line, contact: Manager, W.F.A. Trucking Company, Foster F. Butler, Route 2, Lancaster, Ohio 43130, phone: (614) 969-2585.

A multitude of educational opportunities are available on these 1400 acres of oak-hickory forest, hemlock ravines, 50-acre lake and open fields. Resort facilities available also. Arrangements must be made prior to trip.

State House, Franklin County, The State Capitol, in the center of Columbus.

A natural resource of Ohio, limestone quarried just a few miles away, gives an honest, forthright look to the foursquare Capitol building. A field trip to look at its interior functions as well as its exterior is highly worthwhile.

Transportation Research Center, Union and Logan counties, contact: Deputy Director, East Liberty, Ohio 43319, phone: (513) 666-2011.

The center provides facilities for research and development of all land transportation vehicles. Tours may be arranged when the use of facilities permits.

The U.S. Shoe Corporation, Ross County, 291 South McArthur Avenue, contact: Plant Manager, U.S. Shoe Corporation, Chillicothe, Ohio 45601, phone: (614) 774-1121.

The manufacture of shoes from leather to the finished product may be witnessed by students of the fifth grade and up in groups of 20.

Walden Wildlife Refuge, Franklin County, in Blendon Woods Metropolitan Park, contact: Columbus Metropolitan Park Board, 999 Park Road, Westerville, Ohio 43081, phone: (614) 891-6700.

Elevated observation platforms give students an opportunity to view the lake unseen by the ducks, geese, heron, shorebirds, and other wildlife in their natural surroundings.

Westerville Water Treatment Plant, Franklin County, off Main Street across bridge on right, contact: Superintendent, Westerville Water Treatment Plant, Westerville, Ohio 43081, phone: (614) 882-2350.

Treating one and one half million gallons of water per day for the City of Westerville, this lime soda softening plant affords an excellent opportunity for students to gain an understanding of resource management and water quality.

Westinghouse Electric Corporation — Appliance Division, Columbus Franklin County, contact: Public Relations Department, 300 Phillipi Avenue, Columbus, Ohio 43228, phone: (614) 272-4602.

A trip to this plant gives students an opportunity to see assembly lines for manufacture of appliances they know well—refrigerators, dishwashers, washing machines, and others. They may watch welding and fabricating operations as well, resource management of many kinds.

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GLOSSARY

Adaptation — Any alteration in the structure or function of an organism or any of its parts that results from natural selection and by which the organism becomes better fitted to survive and multiply.

Aerobic — Living or active only in the presence of air or free oxygen.

Anaerobic — Living or active only in the absence of air or free oxygen.

Aggregate — A mixture of different mineral substances separable by mechanical means, as granite; or any hard, inert materials as sand, gravel or pebbles added to a cementing agent to make concrete.

Agglomeration — A jumbled cluster or mass of various parts.

Amorphous — Lacking definite form or character.

Aquifer — Any geological formation containing water, especially one which supplies wells or springs.

Auger — A device that rotates in a cylindrical casing to force bulk materials from one end to the other.

Ballast — Gravel, broken stone, slag placed to give stability, provide drainage and distribute loads on railroad beds.

Bedrock — Solid rock overlaid in most places by soil or rock fragments.

Bedrock geology — The study of bedrock and the changes which it has undergone or is undergoing.

Benthos — The aggregate of organisms living on or at the bottom of a body of water.

Biogeochemical — Describing the science dealing with the chemical change in the composition of the earth's crust and its relation to the plant and animal life of a given region.

Biophysical environment — The place where an organism lives in relation to the heat, air, water and land which make life possible.

Biosphere — The part of the earth's crust, waters and stratosphere where organisms can live.

Biota — The animal and plant life of a region or period.

BOD — Biochemical (or biological) oxygen demand — the oxygen used in meeting the metabolic needs of oxygen-using microorganisms in water rich in organic matter. Ten to 12 parts per million of dissolved oxygen is a good life-sustaining amount.

Bonding — Adhesion between two substances or objects; a linkage between two atoms in a molecule with no difference in electric charge on the two atoms; the linkage formed by the transfer or shift of electrons from one atom to another.

Borrow pits — Excavations usually filled with water to the ground table level created by the removal of earth materials to build up a roadway or overpass where sufficient material is not otherwise available to form the enbankment.

Buhrstone or burstone — Sandstone rocks used for millstones; either of a pair of circular rocks between which grain is ground.

Calcareous — Describes calcium carbonate or limestone materials.

Calcite — A common mineral, calcium carbonate, the major constituent in limestone.

Calcium — An element commonly combined to form limestone, gypsum, and chalk.

Cannel or cannel coal — A variety of bituminous or soft coal of uniform and compact fine-grained texture with a greasy or oily luster and a shell-like fracture; it ignites easily, yields a high percentage of volatile matter.

Canopy — An overhanging covering; in the forest, the dense leaf covering of the tallest trees.

Carbonate sequence — Refers to the hundreds of feet of limestone and dolomite limestone rocks, layer upon layer, which comprise all the Silurian and the lower formations in the Devonian rock sequence.

Cash farming — Refers to production of crops which are immediately marketable as opposed to being used to feed stock.

Centrifugal force — An outward force on a body rotating about an axis.

Centrifuge — An apparatus which rotates at high speed and by centrifugal force separates substances of different density.

Channelization — The process of changing a stream bed by removing obstacles to stream flow; this may mean deepening and widening, removing vegetation and meanders.

Clastic — A textural term applied to rocks composed of fragmental material weathered from pre-existing rocks, and transported mechanically to its place of deposition.

Climate — The prevailing weather conditions of a region taking into consideration temperature, barometric pressure, humidity, precipitation, sunshine, cloudiness and winds averaged over several years.

Community — (Ecologic) An assemblage of plant and animal populations occupying a given area.

Conifer — A plant producing naked seeds in a cone, chiefly evergreens known as gymnosperms.

Deciduous — Refers to trees or shrubs which shed their leaves annually.

Deflocculent — Chemicals added to clay solution in making pottery to increase its ability to flow.

Deposition — The process by which the sediments weathered from pre-existing rocks were laid down in a sea, along a stream, or in a cave.

Devonian — A period of the Paleozoic era of geologic time occurring from 400 million years ago to 350 million years ago. Ohio sedimentary rocks all were deposited in widespread seas during this era.

Dolomite — A common calcium magnesium carbonate rock. It underlies a large part of western Ohio and is Silurian in age, deposited 400 million years to 425 million years ago.

Dragline — An excavating crane having a bucket which is dropped from a boom and dragged toward the crane base by a cable.

Ecology — The study of the relationships between organisms and their environment.

Ecosystem — A unit formed by the interaction of a community of organisms with their environment.

Edaphic — Related to soil conditions.

Effluent — That which flows out or forth, a liquid discharged as waste.

Energy — The ability of a body to perform work, the capacity to produce work; it takes such forms as heat, chemical, atomic, potential and kinetic.

Environment — The sum total of interacting agencies affecting an organism. For man this involves physical, social, economic and cultural factors.

Environmental ethic — A body of values related to the conservation or preservation of natural and man-made resources which guarantees a life of quality.

Erosion — The process by which surface materials are worn away by the action of water, wind, waves or glaciers.

Esker — A ridge of alternating layers of sand and gravel deposited by fluctuating streams within a glacier.

Estuary — That part of the mouth or lower course of a river in which the river's current meets the waters of the sea (or lake).

Eutrophication — The aging of a lake characterized by an abundant accumulation of nutrients that support a dense growth of plant and animal life, the decay of which depletes the bottom layers of oxygen, at least seasonally.

Evaporites — Any sedimentary rock as gypsum or rock salt formed by precipitation from evaporating sea waters. Closed off lagoons or segments of seas where mineral salts have concentrated are usually responsible for such deposits.

Evapotranspiration — The combined process of transferring moisture to the atmosphere by evaporation of water and transpiration of plants.

Feldspar — A group of complicated aluminum silicate rock forming minerals which also contain potassium sodium or calcium. When weathered they are held in suspension in water and settle out as clay.

Flocculent — A chemical used to form a precipitate of suspended particles as in water; or to improve the plasticity of clay in ceramic products.

Flood plain — That portion of a river valley which is built of sediments and is covered with water when the river overflows its banks at flood stage.

Fossilized — Occurs when organic substances are replaced with minerals in the remains of an organism, converting it into a fossil.

Flux — A substance used to refine metals by combining with impurities to form a molten mixture that can be readily removed.

Gather — Reference is to a small mass of molten glass at the end of a tube for blowing.

Gene pool—The total genetic information possessed for a given reproducing population.

Geology — The science which deals with the physical history of the earth, the rocks of which it is composed, and the processes that effect changes.

Glacial drift — An all-encompassing term for any material left by or washed out of a glacier.

Glacial outwash — The sorted or alternating layers of sand or gravel deposited by streams carrying the glacial material.

Glacial till — The unsorted mass of boulders, sand, gravel, silt, clay and rock flour left in place as the glacier wasted back.

Glaciation — The state of being covered with ice and affected by glacial action.

Glacier — A mass of ice formed from snow falling and accumulating over the years which is or has moved under the influence of gravity. The principal types are continental, valley and piedmont.

Gley — A term applied to a soil horizon which is a blue-grey, sticky, compact clay material produced by permanently water logged and hence oxygen — deficient conditions.

Gneiss— A metamorphic rock (changed by heat, pressure or recrystallization) commonly of granite.

Gradient — The slope of a stream or land surface with measurements expressed in percent, feet per mile or degrees.

Graffiti — Words or phrases written on public sidewalks, or on walls of buildings.

Habitat — A place where a plant or animal species naturally lives or grows.

High wall — The wall of rock layers below which the coal has been extracted, left exposed when a strip mine operation is terminated. The new reclamation law in Ohio requires with exceptions that material removed must be returned to obliterate high wall.

Hildreth letters — Refers to letters of Samuel Prescott Hildreth—1783 to 1863, in *Biographic and Historical Memoirs of the Early Pioneer Settlers in Ohio*, published in Cincinnati, 1852.

Hydrologic cycle — The movement of water from the sea by evaporation and by the transpiration of plants to the atmosphere, by precipitation onto the land, and by movement under the influence of gravity back to the sea again.

Igneous rock — A mass of minerals that have solidified from a molten mixture of naturally occurring materials originating within the earth.

Industrial minerals — Rocks and minerals, not processed for metals and excluding mineral fuels, used for construction, primarily. Sandstone, limestone, clay, sand, gravel are common industrial minerals.

Inversion — The phenomenon of a layer of cool air trapped by a layer of warmer air above it so that the bottom layer cannot rise. This is a special problem in polluted areas because the contaminating substances cannot be dispersed.

Kame—A steep sided hill of layered sand and gravel deposited by water within or at the edge of a wasting glacier.

Kaolin — A clay, mainly hydrous aluminum silicate, weathered usually from alkali feldspars. Also called China or porcelain clay and used for fine white ware.

Kiln — A large furnace used for baking or burning firebrick, ceramic ware or cement.

Leaching — The removal in solution of the more soluble minerals by percolating waters.

Lignin — An organic substance, which, with cellulose, forms the chief part of woody tissue.

Meltwater — Water flowing from a glacier as a result of melting.

Metamorphic rock—An igneous or sedimentary rock which has undergone physical or chemical changes or both. The agents of metamorphism are heat, pressure and chemically active fluids. Common changes are quartzite from sandstone, marble from limestone, and gneiss from granite.

Mineral — A naturally occurring element or compound with a definite chemical composition, and a unique crystalline structure.

Mineral fuels — Particularly coal, lignite and petroleum with natural gas generally included.

Moh's scale — An arbitrary list of minerals, each of which will scratch all those lower in number on the scale and will be scratched by all those higher. They are: talc, 1; gypsum, 2; calcite, 3; fluorite, 4; apatite, 5; orthoclase, 6; quartz, 7; topaz, 8; corundum, 9; diamond, 10.

Moraine — A general term applied to land forms composed of glacial till.

Mulch — A covering left or spread on the ground around plants to prevent excessive evaporation or erosion and to enrich the soil. It may be leaves, grass, straw, wood bark or compost material.

Natron — A mineral, hydrated sodium carbonate or soda ash.

Natural vegetation — Pertaining to plants indigenous to a specific environment.

Nuclear fission — The splitting of an atom into new or lighter nuclei, especially applied to heavy atoms producing atomic energy.

Nuclear fusion — The union of atomic nuclei to form heavier nuclei resulting in the release of enormous quantities of energy, as the union of heavy-hydrogen nuclei to form helium nuclei that takes place in the sun or a hydrogen bomb.

Nuclear reactor — An apparatus in which a chain reaction of fissionable material is initiated and controlled for the generation of heat for power or for production of plutonium from uranium.

Ordovician — A period in the Paleozoic era, occurring 440 million to 550 million years ago. Rocks of Ordovician age are exposed in southwestern Ohio.

Organic matter — Material derived from living organisms.

Outlier — A portion of a formation isolated by the erosion of surrounding parts.

Outwash — Material carried from a glacier by meltwater, laid down in layers (or stratified).

Overburden — Material of any nature, consolidated or unconsolidated, that overlies a deposit of useful materials such as coal and ores. Also describes loose soil, sand or gravel that lies above the bedrock.

Particulate matter — Minute separate particles. Often refers to the fly ash from the combustion of coal.

Pennsylvanian — A period in the Paleozoic era of geologic time, occurring from 270 million years to 300 million years ago; coal of eastern and southeastern Ohio. It is also called the Carboniferous or Coal Measure Formations.

Percolation — The state of passing through a porous body, as water passing through soil and porous rock until it reaches the ground water zone of saturation.

Permean — The last period in the Paleozoic era of geologic time, occurring 220 million to 270 million years ago. Rock found in Ohio on the extreme southeastern edge.

pH — The negative logarithm of the hydrogen ion activity (less correctly, concentration). PH 7 indicates an H+ concentration (neutral) of 10-7 mole/liter (the molecular weight of a substance expressed in liters). A pH reading of under 7 is an acid concentration, over 7 is an alkaline concentration.

Physical environment — Refers to the total nonliving parts of the environment — heat, light, air, water, rocks and soils — and the processes which they undergo or cause to be undergone.

Plankton — The aggregate of passively floating or drifting organisms in a body of water, chiefly minute such as protozoans and diatoms.

Plastic — Capable of being molded or of receiving form.

Pleistocene — A recent period in geologic history considered to have begun a million years ago and characterized by periods of glaciation and the appearance of man.

Pollution — The contamination of a medium (air, water, soil) with impurities to an unhealthy or esthetically displeasing level.

Populations — The assemblage of plants or animals living in a given area.

Precipitates — A substance separated in solid form from a solution as by means of a reacting chemical.

Punty — An iron rod used in glass making for handling the hot glass.

Pyrite or pyritic — A common brass yellow mineral, iron disulphide, which is found in clays and coal. It is an important source of sulphur. When exposed to air and water it produces sulphuric acid.

Reclamation — The process of reclaiming land after stripmining for cultivation or other use. In the new law (1972), reclamation begins within three months; the operator must backfill, grade and replace the top soil. Planting must begin in the next appropriate season.

Recycle — To pass again through a cycle of changes or treatment as glass bottles are melted down and made into new glass bottles.

Relict vegetation — A plant living in an environment that has changed from that which is typical for it.

Relief — A contour variation of the land surface in relation to the surrounding land.

Remnant vegetation—Relict vegetation, or survivor.

Rennet — A preparation or extract of the rennet membrane used to curdle milk as in making cheese, or junket.

Residual soils — Soils formed in place by the disintegration and decomposition of rocks and the consequent weathering of the minerals. They are presumably developed from the same kind of rock as that on which they lie.

Retreating glacier — A glacier no longer advancing by the force of gravity but wasting away, thus seeming to retreat.

Rip-rap or riprap — A foundation or sustaining wall of stones thrown together without order. It is used for river or harbor work, spillways at dams, shore protection, docks or other similar construction which must resist the force of the elements.

Rock — An aggregate of minerals of different kinds in varying proportions which constitutes an appreciable part of the earth's crust.

Sand barren — A relatively infertile soil region composed almost entirely of sand.

Sediment — Fragments or minerals derived from the breakdown or weathering of pre-existing rocks.

Sedimentary rock — Rock formed from sediments which have accumulated in bodies of water and subsequently compacted or cemented into hard, true rocks.

Seiche — An occasional and sudden oscillation of the water of a lake, bay, or estuary, causing fluctuations in the water level, caused by wind, earthquakes or changes in barometric pressure.

Sewage treatment — The processing of waste by bacterial action, chemical precipitation, filtration and/or aeration.

Silica flour — A sand additive, containing about 99.5 percent silica produced by pulverizing quartz sand in large ball mills.

Siliceous — Relating to or derived from silica or quartz.

Silurian — The third period in the Paleozoic era of geologic time extending from 425 million years ago to 400 million years ago. Much of western Ohio is underlain by Silurian rock formations.

Site studies — Refers to a careful observation and analysis of interrelationships for a specific area.

Slurry — The suspension of a solid in a liquid; applied to cement mixture, pottery liquid, sewage.

Soil parent material — The horizon of weathered rock or partly weathered material from which the soil is formed. It is horizon C in a soil profile.

Soil profile — Zones or horizons beginning at the surface that have altered by normal soil forming processes of which leaching and oxidation have been particularly important. Soil varies with climate, plant and animal life, time, slope of the land and parent material. Horizon A is the topsoil containing humus and a zone of leaching; horizon B is the colloidal concentration of leached minerals; horizon C, the partly weathered parent material; horizon D, bedrock or transported glacial material.

Species — The major subdivisions of a genus or subgenus regarded as the basic category of biological classification, composed of related individuals that resemble one another.

Spoil (banks) — Debris or waste material from a coal mine.

Stratigraphic — Reference is made to sedimentary rocks formed in beds or layers.

Stream flow augmentation — Refers to a program of replenishing stream flow by pumping water from the ground water reservoir, or from downstream to a problem area above.

Striation — A scratch or groove gouged into rocks by glacial action. Striations are oriented in the direction of ice flow across that surface.

Sulfur dioxide — A heavy colorless gas, SO_2, that is toxic to plants and fairly toxic to man. It is produced by burning coal and by smelting and other industrial processes.

Thermal pollution — Unwanted heat; usually refers to waters warmed by use in industrial plants and returned to streams uncooled.

Till — Unstratified and unsorted glacial material deposited directly by ice.

Tilth — The operation of cultivating or tilling the land or the physical condition of the soil in relation to plant growth.

Topography — The relief features, relations or configurations of a specific land surface.

Trade-off — Compromise, sacrifice; the process of giving up something in order to gain something else.

Transpiration — The process of giving off water vapor or odor through the surface as with the body or leaves.

Understory — The area lying below the canopy in a forest.

Vermifuge — A medicine serving to expel worms or other animal parasites from the intestines.

Vetch, crown — Leguminous plants cultivated for forage and soil improvement.

Watershed — The area contained within a drainage divide above a specified point on a stream. Thus, if so designated, the Mississippi River watershed could be treated in its entirety, as could a small tributary of a tributary in Ohio.

Water table — The upper surface of the zone of saturation for underground water. It is an irregular surface with a slope or shape determined by the quantity of ground water and the permeability of the earth materials. In general it is high beneath hills and low beneath valleys.

Weathering — A number of processes whereby rocks on exposure to weather change in character. May be mechanical, chemical, or biological.

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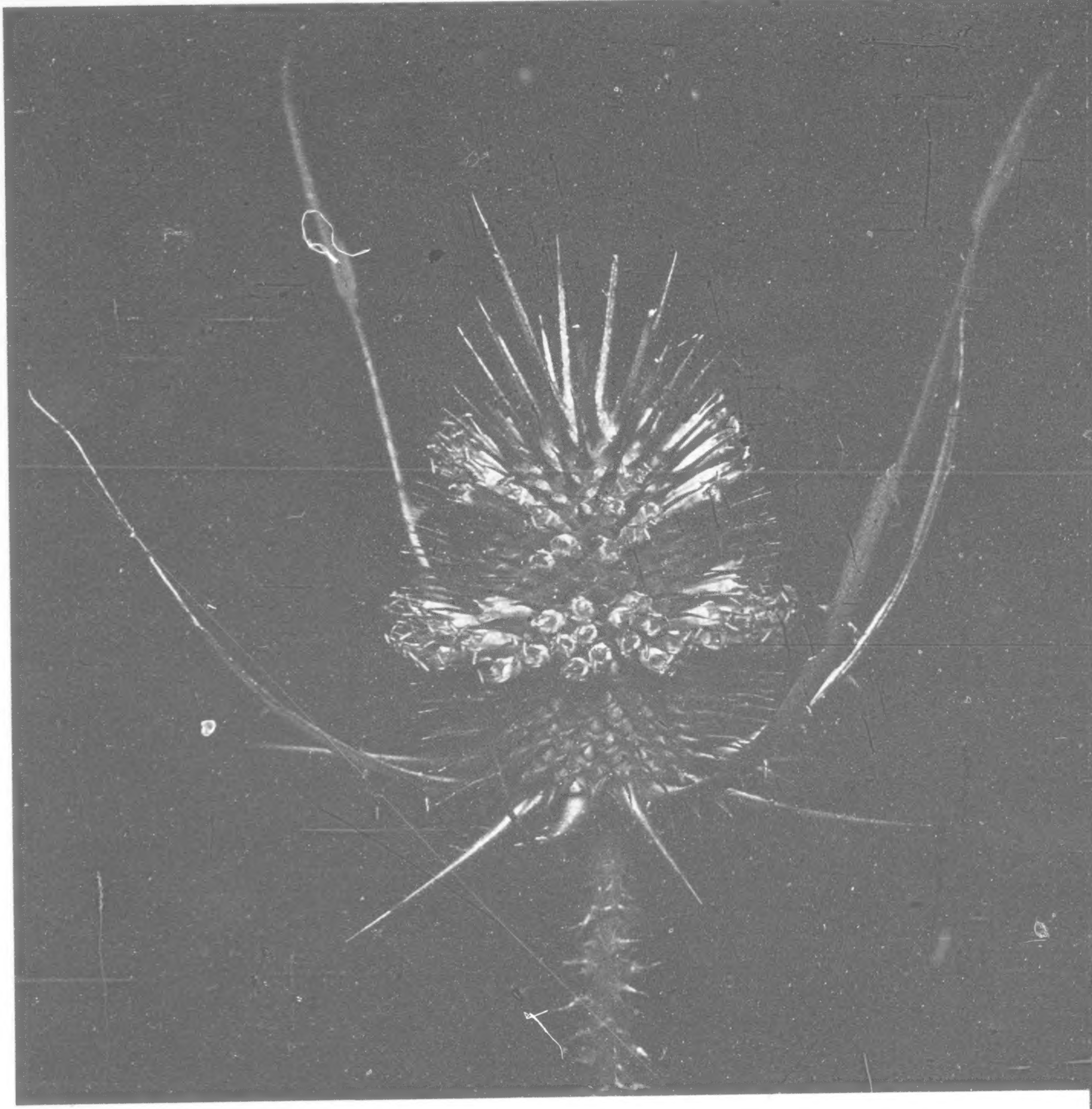

Teasel (Dipsacus sylvestris)